AUTHOR'S EDITIO

FROM THE ANNUAL REPORT ON THE EXPERIMENTAL FARMS FOR THE YEAR 1896

CANADA

DEPARTMENT OF AGRICULTURE

CENTRAL EXPERIMENTAL FARM

[RE]PORT OF THE ENTOMOLOGIST AND BOTANIST

(JAMES FLETCHER, LL.D., F.R.S.C., F.L.S.)

1896

OTTAWA
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REPORT

OF THE

ENTOMOLOGIST AND BOTANIST.

(JAMES FLETCHER, LL.D., F.R.S.C., F.L.S).

DR. W. SAUNDERS,
Director, Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to hand you herewith a report on some of the most important subjects which have been brought officially under my notice during the past season. The correspondence of this division is now very large, which I trust may be taken as an indication of the growing appreciation of the utility of the investigations prosecuted. As heretofore, I have endeavoured to come into direct communication with my many correspondents in all parts of Canada, so as to benefit as much as possible from the observations of practical workers and actual eye-witnesses of the different matters studied. It is of course impossible to treat in the annual report of all the subjects which engage the attention of the Entomolcgist and Botanist during the year; but the many valuable data and records of observations in letters from correspondents are all carefully preserved and classified for future use when the subjects to which they refer are treated of in full. Included among these are references to various attacks upon crops, of more or less importance by insects, the study of the life histories of which is as yet incomplete. As in previous years, much time has been taken up in distributing information concerning well known injurious insects and plants. Among the insects which cause much loss every year and which are now being studied with the view of arriving at better remedies, the following may be mentioned :—Wireworms, cutworms in grain, the pea moth, the strawberry leaf-roller, the carrot rust-fly, the "fish-bug" *(Silpha Lapponica*, Hbst.), which attacks codfish on the "flakes" during the process of being cured, root-maggots of the onion and cabbage and white grubs.

The experiments with grasses and fodder plants of all kinds have been continued upon the Experimental Farm, and a large number of small samples of seeds have been distributed to farmers living in all parts of the Dominion for testing. The reports from these correspondents are of great interest as proving the suitability of some of the valuable varieties for cultivation over a far wider area in the Dominion than might have been anticipated. The experimental grass plots on the farm continue to be of great interest to visitors. In these plots may be seen growing nearly all the grasses, clovers and other fodder plants suitable for cultivation at Ottawa, of which the seeds are to be obtained from seedsmen as well as a large number of our native Canadian grasses. Seeds have also been procured from botanists in Australia and in the United States. Among these mention may be made of an erect variety of barn-yard grass (*Panicum Crus-galli*) and two early varieties of Soja beans from Japan received from Prof. W. P. Brooks, of the Massachusetts Experiment Station.

During the past year many entomologists and botanists in various parts of the Dominion have availed themselves of the services of the officers of this division in identifying specimens of insects and plants. A large number of collections have been received for this purpose. From these collections several valuable additions have been made to the farm museum The collections sent in for naming are always returned to the senders with the names of the specimens, but many species which were found to be desirable for our herbarium have been kindly presented to us by their owners upon that fact being made known to them. Through these collections valuable additional information is acquired as to the known distribution of our native insects and plants, lists of the names, localities and dates of all specimens received being carefully kept.

The practical work of the Arboretum and Botanic garden, which was done to a large measure under my direction until last spring, was then, at my request, handed over to Mr. W. T. Macoun, the foreman of forestry, who, having men under his control, was in a better position to look after the necessary labour, such as cultivation, planting, tidying up, &c., than I was, with only one man, whose time is very fully occupied with the grass and fodder experiments. In addition to the above reason, Mr. Macoun is specially well qualified for this work from his natural tastes and knowledge of plants. I had, therefore, very much pleasure in recommending to you that this work should be entrusted to him.

Whenever my official duties would allow of my absence, every opportunity has been taken of attending farmers' meetings to deliver addresses on the work of the division and to meet the farmers. In this way information concerning the work of this division has been spread to many who might not otherwise have known of its utility. Meetings were attended at the following places :—

January 7–10—Campbellford, Ont.
do 14–16—Cornwall, Ont.
February 7– 8—Toledo and Newboro', Ont.
do 10–15—St. Johns and Ormstown, Que.

By instruction of the Hon. Minister of Agriculture, and at the request of the Manitoba government, I proceeded to Manitoba on 23rd June last, and, in company with Mr. Hugh McKellar, Chief Clerk of the Provincial Department of Agriculture and Immigration, or Dr. S. J. Thompson, Veterinarian of the same department, I held a series of twenty meetings in many of the most important wheat growing centres of Manitoba. The subject treated of at all these meetings was "Noxious Weeds, their Nature and Habits, and the best Means to adopt for their Eradication." These meetings were in every case well attended and very great interest was manifested in the subject, large numbers of weeds being brought in at every meeting for naming and information. All arrangements and expenses of these meetings were undertaken by the Provincial Minister of Agriculture, the Hon. Thomas Greenway, who, by associating with me in this work the two above named officers of his department, materially increased the value of the meetings on account of the practical knowledge and long experience of both of these gentlemen in the methods of culture practised in Manitoba, as well as their thorough acquaintance with the capabilities and physical features of the country.

Acknowledgements.—As in previous years, I am under great obligations to my friends, Prof. John Macoun and Mr. W. H. Harrington, for frequent assistance in the identification of difficult plants, insects and other objects of natural history. To Mr. J. B. Tyrrell, of the Geological Survey Department, I am indebted for the identification of specimens of *Arachnidæ.* I also take pleasure in again gratefully acknowledging the valuable assistance I have received from my many correspondents in all parts of the Dominion, who have much aided the work of this division by making observations and by sending me prompt notice of the occurrence of injurious insects and weeds. My thanks are particularly due to Dr. L. O. Howard, the United States Entomologist, and his staff for many favours in the identification of insects, for the use of illustrations and for valuable publications. The following donations have been received, all of which are most acceptable :—

J. R. Anderson, Esq., Victoria, B.C.—Botanical specimens and living roots of five species of British Columbian *Ribes.*

André Bôdy, Esq., Quebec.—Botanical specimens and seeds.

Rev. W. A. Burman, Winnipeg.—Seeds and specimens of Manitoba weeds.

F. C Clare, Esq., Edmonton, Alta.—Specimens of rare plants and insects from the North-west.

M. G. DeWolfe, Esq., Kentville, N.S.—Living root of *Amorphophallus Rivieri*

A. Grant Ferrier, Esq., Sorrento, Florida.—Insects from Florida, including a liv specimen of the whip-tailed scorpion *(Thelyphonus giganteus).*

T. W. Ramm, Esq., Ross Mount, Ont.—Specimens of insects, including a beaut pair of the Imperial Moth *(Eacles imperialis,* Drury) taken in Ontario.

W. Scott, Esq., Toronto.—Botanical specimens.

Rev. G. W. Taylor, Nanaimo, B.C.—British Columbian plants and insects.

T. N. Willing, Esq., Olds, Alta.—Rare plants and insects from Alberta.

The Director, Bangalore Botanic Garden, India.—Several packets of seeds.

In addition to the above special mention should be made of a consignment of pecimens of the Apricot scale, *Lecanium Armeniacum*, infested by its parasite, *Comys usca*, Howard. These were sent by Mr. E. M. Ehrhorn, of Mountain View, California, ith the hope that they might prove useful in controlling the New York Plum-scale, a pecies similar to the Apricot scale. Part of these specimens were allowed to escape in n elm tree at Ottawa badly infested by another *Lecanium* very similar to the two above mentioned, and part were sent to Mr. L. A. Woolverton, Secretary of the Fruit Growers' Association of Ontario, to be liberated at Grimsby where the New York Plum-scale was known to exist.

The most important addition to the museum was in the shape of an exchange from he Government of New South Wales, through the Curator of the Technological Museum t Sydney, and consists of a large collection of named botanical and entomological pecimens from that colony.

In conclusion, I beg again to acknowledge the great help I have received in all ranches of my work from my assistant, Mr. J. A. Guignard, B.A., who has done a great eal to render this division what I trust and confidently hope that it is—a useful branch the public service.

I have the honour to be, sir,
Your obedient servant,

JAMES FLETCHER,
Entomologist and Botanist.

OTTAWA, 31st December, 1896.

CEREALS.

There was not during the past summer any widespread or very serious inj to grain crops by insect enemies. Notwithstanding that in the province of Onta large areas of fall wheat were ploughed down as being "winter-killed," the crop pro of good quality and an average yield. It is highly probable, from the reports that h since come in from the districts where this winter killing prevailed, that some of the l at any rate, was due to the attacks of HESSIAN FLY *(Cecidomyia destructor*, Say*)*, I 1. Actual reports mention this insect only Prince Edward Island and the western par Ontario. In this latter section, however, th is decided evidence that the Hessian fly is creasing, and it is well for farmers to recogi this and adopt the well known methods preventing its injury. In October last Prof H. Panton, of the Ontario Agricultural Coll and Director of the Committee on Econo Botany and Entomology of the Ontario A cultural and Experimental Union, sent ou list of questions to some of the most promin farmers in Ontario. One of these questi was: "What are the six worst insects in y locality?" And another: "What new ins are likely to be injurious?" In an interest summary of the replies to these questic written by Mr. T. F. Paterson for the Mont *Family Herald* of December 15, 1896, appears that "forty-three different insects w enumerated. The following list will give a estimate as to which are most injurious to farmer at the present time. The eight v ones have been selected, as, from the reports, they seem to greatly exceed the others numbers and injurious effects:—1. Colorado potato beetle, 39. 2. Grasshoppers, 3. Horn-fly, 25. 4. Cutworms, 18. 5. Tent caterpillars, 15. 6. Army-worm, 13. Cabbage worm, 11. 8. Hessian fly, 10." From the above, it is also clear that the I sian fly is recognized as the cause of considerable loss in the year 1896, and in answers to the question as to what insects are likely to prove troublesome in the fi it is the fifth of twenty-three kinds mentioned, and the Wheat Midge is the sixth. following letters are from Ontario:—

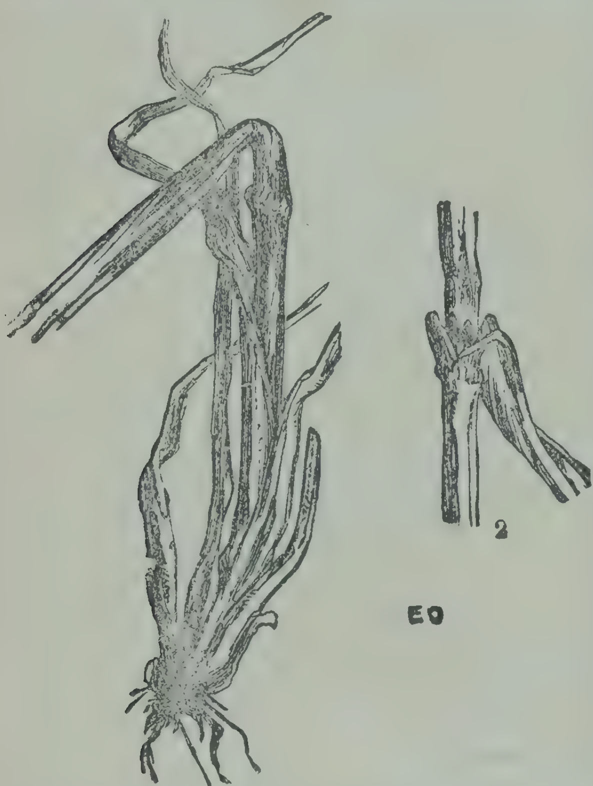

Fig. 1.—Barley stem attacked byHessian fly.
2, Showing flax-seed-like puparia.

"Pinehurst, Kent Co., Ont., 29th June.—In this county the Hessian fly is do great deal of damage to the wheat crop; in fact, many fields are ruined, and, something can be done to protect the wheat, we think it a great risk to sow an fall."—J. T. O'KEEFE.

"Delaware, Middlesex Co., Ont., 2nd Nov.—I am told that the prospects fo wheat are not good in this neighbourhood, owing to the attack of the larvæ of H fly."—J. DEARNESS.

"Verdun, Huron Co., Ont., 1st Dec.—Referring to previous correspondence, beginning to think that the Hessian fly may be blamable for the injury to my fall this autumn; and, if so, there is every year here much loss from it. Much com was made last spring of fall wheat being killed off after it had apparently come th the winter all right, and I am now inclined to think, since communicating with yo the Hessian fly was the cause of this loss also. The condition referred to extende

all this township, and this fall much of the very early sowing (in August) is noticeably yellow in places. I have, however, examined a few fields, but did not find sufficient pupæ of the Hessian fly as would, I think, account for the whole of it. As to the extent of the damage to the wheat crop, six weeks ago as much as one-third apparently was injured, but this is not so noticeable now, owing to the killed plants having withered and the healthy ones covering the ground."—WM. WELSH.

The life history of the Hessian fly is well known, but fortunately this insect has not for some years required particular attention except in restricted localities. Its work is generally recognized in the spring of the year by dead plants in wheat fields. Upon examining these, the characteristic pupæ, resembling small flax seeds, may be found in the crowns of the young plants; sometimes three or four specimens will occur beneath the leaf sheaths of a single plant. In summer time the same flax-seed-like puparia (Fig. 1) may be found above the first or second joint of the stems of barley, rye and wheat, where they lie beneath the sheath of the leaf, but outside the stem; the larvæ suck the sap of the stems and so weaken them that they frequently fall down. The perfect insect is a tiny blackish midge with smoky wings, expanding only a quarter of an inch from tip to tip, which appears in April and May and again in August, lasting until about the middle of September. The females lay their minute scarlet eggs upon the inside crease of the leaves, and the young maggots, upon hatching, work their way down to the axils of the leaves where the injury to the plant is done.

Remedies.—The remedies for the Hessian fly are as follows: 1. Late sowing. The postponement of seeding until after the third week in September has the effect of delaying the appearance of the young wheat plants above the ground until all the Hessian flies of the second brood are dead.

2. Burning refuse. As a large proportion of the "flax seeds" are carried with the grain and at threshing are thrown down beneath the machine among the rubbish and broken straw, it is of great importance to destroy all rubbish, tailings or fine screenings wherever grain is known to be infested.

3. Treatment of stubbles. As soon as the crop is cut, it is an excellent plan to run a harrow over the fields so as to start a volunteer crop from the grains which have dropped in harvesting. By the time the fields are ploughed, many flies of the August brood will have emerged and laid their eggs on these plants; these will thus be destroyed at the same time as many seedlings of noxious weeds. If fields are conveniently situated away from barns, houses and stacks, much good may be done by burning over the stubbles before ploughing, as the pupæ occur, as a rule, at the first or second joint of the stem. To facilitate the operation of burning, a little dry straw may be scattered lightly over the stubble. It is, perhaps, hardly necessary to say that neither wheat, barley nor rye should be sown again in fields where a crop has been infested the year previous.

The JOINT-WORM (*Isosoma hordei*, Harris).—In my last report I made mention of the occurrence in injurious numbers of a joint-worm in wheat fields at Meaford, Grey Co., Ont. My correspondent, Mr. Thomas Harris, who reported his observations last year, writes that there has been no recurrence of this attack during the past summer on his own fields, nor has he heard of any upon the crops of his neighbours.

The GRAIN PLANT-LOUSE (*Siphonophora avenæ*, Fab.)—As usual, this plant-louse has occurred to some extent in all parts of the Dominion, but only two reports state that actual injury has been done to grain. That the insects were exceptionally abundant is shown by the following:

"Princeton, Brant Co., Ont., July 24.—In this part of the province we have begun to cut our oats, and these insects abound to an enormous extent. They literally cover the table of the binder. One farmer told me to-day that they piled up four or five inches deep under the knotter of his machine. I am sure I do not exaggerate when I say it would not be hard to sweep a good shovelful off a binder after cutting a field of oats."—J. E. RICHARDSON.

"Shakespeare, Oxford Co., Ont., July 27.—I send you some small insects. There are millions of them on my oats. I do not recollect having seen anything like it before."—J. W. DONALDSON.

"Doe Lake, Muskoka, Ont., August 18.—The wheat is very much shrunk here. This was not from rust, as the straw was bright, but the heads while green were covered with lice."—F. C. JUDD.

No special treatment can be recommended for the grain plant-louse, nor, as a rule, is any remedy necessary, for the natural parasites suffice to keep it in check.

The AMPUTATING BROCADE MOTH (*Hadena arctica*, Boisd.).—In the summer of 1895, the moths of this species were so abundant in some parts of Western Ontario as to attract the attention of many people, and complaints were received of their swarming into houses where they gave annoyance by soiling clothes and curtains and also by dying in large numbers in shop windows. As might have been expected, the caterpillars were last summer destructive in the same districts to wheat, oats, corn, &c., complaints coming in from the counties of Middlesex, Grey and Carleton. Writing from Granton, Middlesex Co., Ont., Mr. J. Dearness, President of the Entomological Society of Ontario, on 15th of May, says :—"I am sending you herewith samples of a cutworm that in innumerable force is ravaging spring crops sown on sod. The drill rows are followed, and every blade of grass is cut off, leaving large areas of the field perfectly bare. In this neighbourhood last year,—and from reports, I judge it was pretty general through this part of Ontario,—the Amputating Brocade moth was very troublesome, filling lamps soiling clothes and pestiferous in other ways. I inclose one of these moths. Is it the same species as the cutworm sent ?"

Reply :—"The cutworm and moth sent are both the same species. I am sorry to say that the only measure I can suggest by which infested fields can be turned to good use this year, is to plough up the portions worst affected and plant some crop which can be put in as late as possible, so as to give the caterpillars time to mature before the crop appears. It would be better to use some other crop than a plant belonging to the grass family. As far as my own observation goes, *H. arctica* feeds on grasses, although there are many records of the caterpillars feeding on other plants, such as root crops and even orchard trees ; but I have never seen this. They are large whitish cutworms nearly two inches long, with bright chestnut red heads, which exist a long time in the larval form, continuing their ravages almost to the middle of June. They have every appearance of caterpillars which feed normally beneath the surface of the soil."

Serious injury to corn fields, which was probably by the same species, was reported by Dr. T. Sproule, M.P., as occurring in the county of Grey.

The PEA MOTH (*Semasia* sp.) has again this year attracted a good deal of attention by the extent of its injuries. Many of the accounts differ somewhat on important particulars, and it is much to be regretted that, so far, all efforts to breed the perfect insect have failed, so that the exact identity of the moth cannot as yet be given. The following interesting letter adds to our knowledge of its life history :—

"Clifton, King's Co., N.B., February 24.—I have been greatly interested in your report on the Pea Moth. This insect is very destructive here, especially late in the season. Late pease are so damaged by it that they are quite unfit for use as seed unless hand picked. Indeed I have had about all my late seed repeatedly destroyed. Last season, the late garden pease when picked and being prepared for the table were found to be so affected as to be unfit for market, fully three-quarters of them being destroyed by the worm. Late varieties of pease such as Stratagem were so injured that it was almost impossible to get any that were fit for seed.

"The pea pod is always attacked at the upper end first, and, when the pease are badly eaten up a quantity of granular excrement and silken threads unites the whole. The pods on the under side of vines lying on the ground seem to be most badly affected, and the damage is greater on ground planted in pease the year before, in garden plots, in damp positions and when the weather has been damp.

"I notice in your report that Mr. Cowdry says he found caterpillars only in pods quite matured. I have repeatedly found them in very young pods, too young for table use.

"This pest has existed here at least forty years, and I can see no appreciable increase or decrease. It causes considerable loss in this vicinity, but so far no remedy seems to be generally applicable. Possibly deep ploughing might do much, or burning the stems in garden plots."—J. E. Wetmore.

THE WHEAT-STEM SAW-FLY.

(*Cephus pygmæus*, L.)

Attack.—Slender, white grubs. Head rounded, yellowish, with the mandibles darkened. Body swollen at the first two joints after the head and tapering very slightly to the end, which is terminated by a short, blunt tubercle with a darkened and hardened tip. This Monsieur Herpin describes as a tubular appendage, which is capable of being protruded like a telescope, and assists the insect in its progress within the tube of the straw. Beneath the first three segments of the body are three pairs of rudimentary thoracic feet. These larvæ are found inside stems of wheat. When full-grown they are nearly half an inch in length and have by that time bored through all or most of the knots in the stem, leaving a discoloured tunnel extending from the top joint down to the root, where, when mature, they spin thin transparent cocoons in which they pass the winter and change to pupæ the following summer.

In November, 1889, Prof. Comstock published a bulletin (*Cornell Univ. Coll. of Agr., Bull. 11.*) "On a Saw-fly Borer in Wheat," in which he gives a full account of a remarkable outbreak of *Cephus pygmæus* on the Cornell University farm, when nearly five per cent of the wheat in a field was infested. In the *Canadian Entomologist* for 1890, page 40, Mr. W. Hague Harrington records that in 1887 he took a specimen of this insect at Ottawa, and that he had received specimens taken at Buffalo, N.Y., in the middle of June, 1888, and again at the same place and season the following year. With the exception of these records, I have been unable to find any mention of specimens being taken in America. On the 5th July, 1895, at Indian Head, N.W.T., I collected specimens of the perfect insect by sweeping the flowers of the Tumbling Mustard which grew in the greatest abundance just outside the Experimental Farm. At that time no injury by the larvæ was noticeable on the wheat growing in the district, nor has any report of injury attributable to it been received since from that district; but on the 6th of August last Mr. John Wenman, of Souris, Man., sent a packet of wheat stems containing nearly full grown larvæ which answered in every particular to those of *Cephus pygmæus*. Mr. Wenman was written to for full particulars of the occurrence, and the following letter was received :—

"Souris, Man., Sept. 2.—In reply to your favour of the 12th ultimo, I beg to inform you that I have looked several times for more specimens of the injured stems of wheat, but the field which was most visibly affected had been cut the day before your letter came, and I could not secure good specimens. You ask how it was that I noticed the injury. I observed that some straws were lying down or lodged here and there, and, upon examining these stems, I found in nearly every instance that the straw was discoloured and broken between the first and second joints. We had had hail a day or two before. On following up inside the affected stems, I found in most cases the grub which you saw in the sample sent, about half an inch long, head brownish and body cream-coloured. In one case I found the grub had worked through all the joints up to the head of grain. I looked for this pest in several of my neighbours' fields. I saw a little in one field. The damage resulting from this attack, however, is so far, I am sure, not appreciable, but precautions must, of course, be taken, and I shall be on the *qui vive* for any further visitation."

The specimens of straw sent by Mr. Wenman contained larvæ which were nearly or quite full-grown on the 12th of August, but only a small proportion of these stems had been tunnelled up to the top joint. The larvæ were some distance above the root, but judging from the state of maturity of the straw, they would have descended very soon to the root to form the cocoons in which they pass the winter.

There is, however, a marked difference in the season of the Manitoban specimens and that of those studied by Prof. Comstock at Ithaca, N.Y., which were in general terms just about one month earlier. By the 19th of July, 1889, all the larvæ examined at Ithaca had descended to the lowest joint, while in Manitoba this year, nearly a month later in the season, some of the larvæ were not full-grown until about the 13th of August. Specimens of the mature insect were flying at Indian Head on the 5th of July, 1895, and it would take from a month to six weeks before the larvæ from eggs laid by these reached full growth, which would occur about the same time as the ripening of the wheat, when naturally the straws would dry up and become unfit for food.

Several European writers have treated of this insect and its habits. Probably the best known account is that of John Curtis in his celebrated work *Farm Insects* (1860). This account includes the observations of Herpin and other French authors. The most complete study of the insect is that by Prof. Comstock presented in the bulletin above referred to.

A summary of the life history of the Wheat-stem Saw-fly is as follows:—

The eggs are laid inside the wheat stem just before the ears appear above the sheath, being inserted into the hollow of the stem through a minute hole cut by the female with its saw-like ovipositor. The egg hatches in a few days, and the young larva grows rapidly and attains full growth before the straw ripens and hardens, by which time it will have eaten its way from the topmost joint of the stem to the lowest, feeding chiefly on the substance of the knots, but also on the inside tissues of the straw. About the time the grain ripens, it descends to the bottom joint, and, just above the surface of the ground, gnaws away the inside substance of the straw so as to cut a ring almost, but not quite, through to the outside. (Fig. 2.) This is to enable the perfect fly to emerge easily in spring. It then spins a thin, delicate cocoon; and, like the larvæ of most saw-flies, remains torpid until the following spring, when it turns to a pupa only a few days before transforming into the perfect fly. The date of appearance of the perfect insect evidently varies with the season and locality. The adult is a shining black four-winged fly, banded and spotted with yellow, with the abdomen slightly compressed. The head is large, with prominent eyes, and there are also three ocelli or minute simple eyes near the summit of the head. The antennæ are slightly club-shaped and composed of about twenty segments. The female is rather larger than the male and less ornamented with yellow. The average length is about one-third of an inch (male, 8 mm.; female, 10 mm.). This insect is interesting scientifically, as it must be classified between the true Saw-flies *(Tenthredinidæ)* and the Horn-tails (*Uroceridæ*), so-called from the fact that the larvæ bear a sharp horn-like appendage at the end of the body.

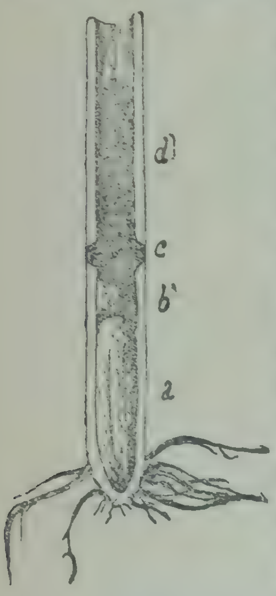

Fig. 2.—Base of straw infested by Wheat Saw-fly: *a*, cocoon; *b*, plug of borings; *c*, circular cut; *d*, scattered borings. (Figure kindly lent by Prof. J. H. Comstock.)

It is evident from an examination of the different stages, that it is more nearly related to the Horn-tails. The Wheat-stem Saw-fly is a native of most of the countries of Europe, and in some years, particularly in France, it has been the cause of much loss. Miss Eleanor A. Ormerod speaks of it in many of her invaluable reports, and shows that while it occurs in noticeable numbers every year, it is only occasionally a serious enemy to the wheat grower.

The question of the introduction of this European insect into America is one of some interest to entomologists, and it seems difficult to understand how it could have taken place. It has been suggested, however, by Prof. Comstock, who found a few cocoons in the straw above the point where it would have been cut by a reaper, that "a small proportion of the insects are probably removed from the wheat fields in the straw and, consequently, there is danger of the spreading of the species in this way. It is probable that the insect was introduced into this country in straw used in packing, and it may be further distributed here in the same way." (*Bull. No. 11*, p. 141).

It is, of course, possible that the insect may have been introduced in this way and although recorded only from the above mentioned widely separated localities, from the inconspicuous nature of the injury, it is extremely likely that it has been overlooked in many places where it occurs. It has not yet been found feeding in any other member of the grass family than wheat and rye. With regard to its occurrence at Ithaca, N.Y., Mr. Slingerland writes under date 28th December, 1896:—"*Cephus pygmæus* has not attracted noticeable attention here in our locality, nor in our State, as far as I know, since Prof. Comstock discussed it in *Bulletin 11*. I do not know that it occurs in any other State, although it is suspected that it occurs in Ohio and West Virginia."

Remedies.—As nearly all the larvæ pass the winter in the base of the straw, it is quite evident that the most practical remedy will be found in treating the stubble, so as to destroy them or the pupæ before the flies emerge. This may be done either by ploughing deeply after harvest, or by burning over, which for another reason also will certainly be a most useful practice in Manitoba, for in that province, on account of the usual plan of growing wheat for several successive seasons on the same land, some bad weeds have increased enormously. The burning over of stubbles in autumn will certainly destroy vast numbers of these and their seeds, as well as at the same time the larvæ of the Wheat-stem Saw-fly. In Manitoba a great deal more straw is produced every year by farmers than they can possibly feed or use otherwise, and as a consequence, as soon as the farmer knows how much he will require, the residue, a large amount, is burnt every spring, simply to get it out of the way. Should the Wheat-stem Saw-fly ever increase sufficiently to affect the yield appreciably, the burning in autumn of the straw not needed would undoubtedly be a wise practice, as it is known that a few of the cocoons, at any rate, are formed in the straw.

THE ARMY-WORM.

(Leucania unipuncta, Haw.)

Fig. 3—The Army-worm.

Attack.—Brown, or sometimes blackish, striped caterpillars (Fig. 3), eating the leaves and stripping the stems of grasses and many other low plants. When attacking cereals, frequently cutting off the heads. When full-grown, over an inch and a half in length, and when occurring in large numbers, migrating in bodies from one food patch to another. On reaching full growth, the caterpillars burrow into the ground and turn to light brown chrysalids, from which in about two or three weeks the moths emerge.

These (Fig. 4) are of a warm satiny-brown colour sprinkled with minute black specks, and with a small but distinct white spot in the middle of each upper wing. They are very active. When the wings are closed, the moth measures about an inch in length.

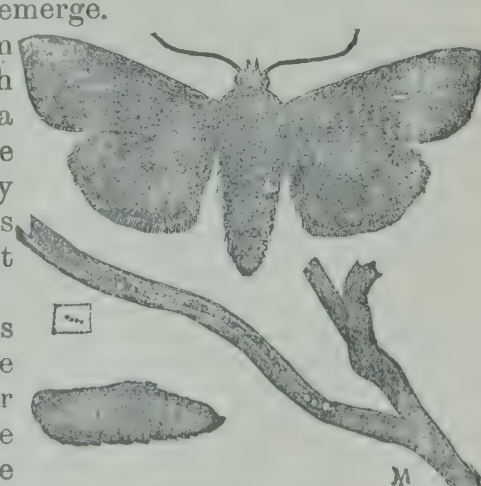

Fig. 4.—Chrysalis, moth and eggs of the Army-worm.

The life history of the Army-worm in Canada is as follows: There are two broods in the year. Eggs are laid in autumn and hatch in ten or twelve days. After feeding for a short time, the small caterpillars, like many of the cutworms, become torpid and pass the winter beneath tufts of grass and other low herbage. In the following spring they complete their growth, feeding on the young grass and grain crops, and produce the moths in June. These lay eggs for the second brood, which is usually much the more numerous and destructive. By the latter part of July, in this part of Canada, the young caterpillars are large enough, when abundant, to attract attention by their depredations. They are full-grown by about the first week in August, when, burrowing an inch or two into the

ground, they change to chrysalids and emerge as perfect moths towards the end of th month.

It has been noticed by many observers that Army-worms are frequently destructiv in seasons following years of unusual drought and that they are seldom abundant in th same place for two successive years. In 1895 collectors of insects were struck by th number of Army-worm moths which flew into houses or were seen in several parts a Ontario. From this it was feared that there might be trouble from Army-worms durin the present year. This turned out to be the case, for in July and August reports c serious injury were received from almost every part of the province, from Russell count in the extreme east to Essex in the extreme west, and from Welland to Algoma distric The loss was greatest, according to the *Ontario Crop Report* for August 13, 1896, i Essex, Kent, Haldimand, Welland, Lambton, Huron and Wellington. Nor was los from the Army-worm confined to Canada, but considerable harm was done in some c the Northern United States. In the *Massachusetts Crop Report* for July, 1896, a goo article on this subject appears by Mr. A. H. Kirkland, and at the last meeting of th Association of Economic Entomologists held at Buffalo in August, 1896, injuries b Army-worms were mentioned by other entomologists.

The Army-worm feeds, under ordinary conditions, upon various members of th grass family, having apparently a special preference for oats and timothy, but it als occasionally injures seriously rye, barley, wheat and many grasses, as well as, when suc food is scarce, pease, beans, lettuce and other vegetables. Mr. Kirkland records that th loss in the Massachusetts cranberry swamps from Army-worms was very considerabl this year. He also made some interesting observations on the periods of occurrence c the different broods and found that this year there were three broods in Massachusett As stated above, we have only two broods in Canada, but according to Dr. L. C Howard, there may be as many as five or six broods in the south. In the *Ontario Cro Report* referred to above, is given a long list of extracts from correspondents in all part of Ontario. The following from some of my correspondents give interesting information o the subject. Those extracts which bear upon the unusual abundance of the moths agai this year are of exceptional interest, and in Mr. Metcalfe's experience at Port Hope i catching a large number of the mature moths, we may have the suggestion of a remed which it would pay to practise on a larger scale when the moths are noticed to b unusually abundant. Of course, when this is the case, not only should the moths b captured as much as possible, but infested lands, whenever possible, should be burn over in the autumn or early spring and a keen lookout should be kept the followin year for the first appearance of the Army-worms, so that the well-known remedies ma be applied.

"Marshville, Monk Co., Ont., July 3.—You will find inclosed some most voraciou insects which are in my rye in innumerable numbers; they have nearly destroyed it and a now moving on to my corn. What are they? How long will they live? What can b done for them? They seem to have been bred in my fall grain. Are they confined t it? They have eaten the timothy (small) out of my rye, and have left the clover as ye but I am sure they will eat it when hungry. Please give me as early an answer a possible."—J. E. Reamly.

"Humberstone, Welland Co., Ont., July 9.—I write in relation to a pest whic appeared suddenly in this district one week ago, about the 2nd inst., the Army-worn This place is a village on the Welland Canal, one mile north of Port Colborne and Lak Erie. About a mile below this place, and extending two or three miles, is a tract of lo land, the soil being a black loam. It was in this tract of land, on the farm of Jame Phillips, two miles north of this place, that the Army-worms were first noticed i countless numbers destroying principally oats and corn. In the oats, these worms firs take the leaves, then the head, afterwards the stalk. Some farmers are applying Par green to their corn crop. Is that safe or desirable? What is it advisable to do, in ord to prevent their destroying the oat crop? Can anything be done to prevent the entering any field? The worms are of various sizes, from half an inch to one inch an a half in length, and are of a dark colour. All the information the farmers can give i relation to their origin is that on the night of the 1st of July there had been a sligh

frost and when they examined their crops the next morning they found countless numbers of these worms in their oats and corn. They come in such numbers that they make a clean sweep of all before them, and unless some way can be found to check their ravages the damage they will do will be exceedingly great. The most of the destruction, so far, has been in the tract of low land referred to. We are anxious to hear from you as soon as possible."—C. E. THOMPSON.

"Diamond, Carleton Co., Ont., December 8.—I received your letter and report *re* the Army-worm, and thank you most sincerely for the promptness with which you answered my inquiries. I followed your directions, rolling and ploughing, and found that it destroyed them greatly. I used a three section roller, and where the ground was level it did good work. Where the surface was rough I ploughed three trenches and in the third I sank holes, as you described, and there did not half a dozen succeed in crossing. It was pasture land, and they were heading for the grain, but never reached it, so that I am unable to say anything with regard to fighting them in the grain. They did considerable damage in some parts of this township, Fitzroy, in the grain."—JOHN GREENE.

"Jermyn, Peterboro' Co., Ont., August 10.—I send some moths which came into our house last night in thousands."—SAMUEL ARMSTRONG.

"Toronto, August 18.—The Army-worm moth (*L. unipuncta*) has been very numerous this fall, literally swarming everywhere during the first three weeks in August."—JAS. H. McDUNNOUGH.

"Port Hope, Durham Co., Ont., August 11.—Several large honeysuckles are growing in my garden covered with berries which attract hundreds of Army-worm moths at night."—REV. C. J. S. BETHUNE.

"Port Hope, Durham, Co., Ont., Nov. 11.—I have been doing some collecting this fall that may be of economic value, viz., the collecting of over six hundred Army-worm moths, mostly females, at sugar. Would not killing the moths thus attracted be a very effective way of fighting them?

"While collecting larvæ last spring, the Army-worm did not appear as common as usual, and so I was surprised at the large numbers of the moths that were flying about the first week in June. They swarmed on the under side of pine branches and hovered about the bloom of the barberry in small clouds. No armies appeared in my immediate vicinity, the larvæ not being in such numbers as to get ahead of the supply of their natural food. They fed on Quack Grass (*Agropyrum*), Fox-tail (*Setaria*) and Wild Buckwheat. After the pease were pulled, the caterpillars sheltered under the bundles and I had a good opportunity to examine them. The bulk were plentifully dotted with the eggs of a Tachina fly. Those very useful beetles, *Calosoma calidum* and *Harpalus caliginosus*, were busily feasting on them. These beetles were innumerable, and, when the wind changed after a land breeze, would be washed up on the lake shore in bucketfuls.

"About August 10, I commenced sugaring; the bait was smeared on the supports of an open shed facing the north, this, of course, being an unfavourable position, but, notwithstanding, the moths came readily to the sugar. The largest catch was made on the evening of August 17, when I took over a hundred before nine o'clock. Over six hundred were taken before August 25. The mixture used was made by dissolving sugar in hot water and adding enough rum to give an attractive odour."

"Port Hope, Ont., Dec. 1.—Many of our common beetles are washed up in great numbers on the shores of the lake here, at Toronto and at Grimsby, as well as members of the other orders. After a north wind of one or two days' duration the wind usually shifts till it blows from a southerly direction, and then is the time for a harvest of beetles on the lake shore here. While at Grimsby (on the other side of the lake) in the summer of 1894, on only two or three occasions did the wind blow on shore, the balance of the time it blew almost continuously from the south. I found many good things on the rare occasions of a north wind."—W. METCALFE.

Remedies.—Under this head I have nothing to add to what appeared in my annual report for 1894 as follows:—

"Although only occurring occasionally in excessive numbers, and then in but few localities, this moth is very widely distributed in Canada, and may generally be found

in most parts in low lands where the caterpillars have suitable conditions for growth and an abundance of food. It has also been observed that the Army-worm is most abundant in wet seasons following a dry autumn, the damp weather giving them the same conditions over a large area as they would find in their own special habitat, viz., low, swampy, and grassy places.

"When the caterpillars appear only in moderate numbers, they have an abundant food supply, and do not then acquire the habit of 'marching,' which is merely moving from one place where all the food has been devoured, to a fresh pasture. When, however, their occurrence is excessive, they must of necessity move on to some other place or starve. They may be prevented from marching from one field to another by ploughing a deep furrow across their path. This should be cleared out so as to leave the edge nearest to the field to be protected, perpendicular or slightly overhanging. Along the trench so formed, pits must be dug about 12 feet apart. When the caterpillars come to the trench, they are unable to climb up the opposite side, and after a few trials, walk along until they fall into the pits, when they may be destroyed by covering them with earth and tramping it down, or, as Prof. Lugger, of Minnesota, suggests, 'with a liberal dose of kerosene oil and water. Even a shallow ditch will answer this purpose if the earth is made friable enough to keep the worms from ascending. If a log is dragged continually through such a ditch, nearly all the worms collected there are either killed or maimed.'

"If pits are not dug, when the caterpillars occur in large numbers, the trench will soon be filled, and they will walk over on the bodies of their fellows. In case any of the worms succeed in crossing the ditch, a narrow strip of the plants on the opposite side of the trench should be dusted or sprinkled with a strong mixture of Paris green diluted either with 25 times its weight of flour, ashes or land plaster, or mixed with water as strong as one ounce to a pailful of water.

"When an attack has been very severe in any locality, much good may be done by burning the old grass and stubble in autumn or spring; in this way, many of the young larvæ are destroyed, as well as the old stems, which it seems are the favourite place for the spring brood of moths to lay their eggs upon.

"An encouraging feature in connection with an invasion by the Army-worm, is the fact that it is extremely rare for the insects to appear in large numbers two years running in the same place. This is due to the fact that they are almost invariably attended by parasitic foes, which destroy them so effectually that the occurrence of two consecutive 'Army-worm years' in the same locality is almost unknown."

FODDER CROPS.

The injuries to fodder crops during the summer of 1896 were chiefly by the Army-worm and Grasshoppers. Occasional mention was made of the work of the Clover Seed Midge, which, however, is found to be far wider-spread over the Dominion than is indicated by reports, because this insect is mentioned only by correspondents in the seed-growing districts. Undoubtedly much clover was killed out by the droughts of 1895 and 1896 and by the severe cold of December, 1895, and January, 1896, which came when there was no snow on the ground. The work of the Clover-root Borer (*Hylesinus trifolii,* Miller) was reported by Mr. R. A. Harvey, of Laskay, York Co., Ont.

WHITE GRUBS, the larvæ of the different species of June beetles (*Lachnosterna*), have been reported as injuring meadow lands and lawns. The good work of robins and high-holders (golden-winged woodpeckers) in destroying the grubs on an infested lawn is mentioned by Mr. J. F. McDonald, barrister, of Dunnville, Ont. Another instance involving considerable injury was on the land of Mr. Caius M. C. Hubble, of Sand Hill, Ont., who writes:—"I dug up these grubs all the season among potatoes, carrots, corn and turnips; but they are most numerous in the carrots. The last I found was on November

6. They were in the same condition as those I dug up in the summer. There are a number of tall poplars bordering my garden which, no doubt, were the cause of my having such a number of these grubs. For a piece of ground adjoining mine, where there are only three or four apple trees near it, had very few. About one-tenth of my ground where I had white carrots was badly infested, but I found them scattered among other crops. It is a very unusual occurrence for them to be so abundant here."

COTTONY GRASS-SCALE (*Eriopeltis festucæ*, Fonsc.).—There has been little reference during the past summer to this insect, treated of in my last report. Mr. D. G. Crawford, of Sydney Mines, C.B., N.S., says:—"I noted that the egg-sacs began to be formed about 21st July, and they were not nearly so numerous as last year, but appeared in other localities to a limited extent. I believe they will disappear in a year or two."

GRASSHOPPERS.—The three species of grasshoppers which have this year committed depredations on fodder and grain crops throughout the Dominion, are the same as were injurious last year, namely, the Common Red-legged Locust (*Melanoplus femur-rubrum*, DeG.), the Lesser Migratory Locust (*M. atlanis*, Riley) and the Two-striped Locust (*M. bivittatus*, Say). These were reported as very abundant in some parts of Ontario and Quebec early in the season. In the *Ontario Crop Report* for August 13th, there is frequent mention of their attacks upon spring and fall wheat, barley, corn, pastures, and even on hops.

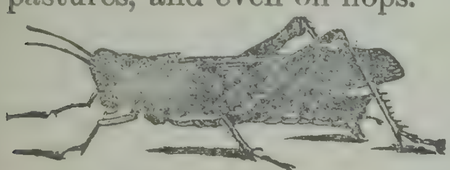

Fig. 5.—A Locust.

Locusts are generally spoken of by correspondents as Grasshoppers, and I cannot see the least objection to using the words "Grasshopper" and "Locust" indiscriminately, for although entomologists claim that the word "Locust" is the more accurate name for those species with short antennæ (the Acridiidæ), the name "Grasshopper" is so universally used and understood for these insects by the public in general that it is certainly wise to recognize this word, at any rate, in these reports prepared especially for farmers or those who, with very few exceptions, are not entomologists. Particularly is this the case as it seems difficult to understand why the word "Grasshopper" should be restricted to the Locustidæ, or long-horned grasshoppers, while the word "Locust," which we might naturally suppose would most aptly apply to the Locustidæ, should be considered the accurate popular name for the Acridiidæ, or short-horned species. Possibly, it may have been because the plague of locusts mentioned in the Bible was known to have consisted of a short-horned species, and the application of the word for that reason has become so well known as applied to those forms with short antennæ that, to some, it has seemed unwise to change it.

The correspondence during the past season, concerning grasshoppers, their injuries and their enemies, is too extensive for us to give more than a few extracts.

"St. Lin, L'Assomption Co., Que., June 7.—Please tell me the best and most economical plan for destroying grasshoppers. They threaten to destroy the whole crop."—J. P. ARCHAMBAULT, *Secretary of Agricultural Circle.*

"Mastai, Quebec Co., Que., August 19.—Grasshoppers eating up cabbages."—H. F. HUNT.

"Port Elgin, Bruce Co., Ont., June 16.—During the past few weeks there has been a plague of grasshoppers in this vicinity. They follow the roadsides, eating the grass so closely that it has the appearance of being singed by fire. At intervals they enter the fields, starting at one point and sweep everything clean before them, such as oats, hay and pasture,—pease, so far, being the only exception. In the evening they gather in countless numbers on the fences of the field they intend to devour, and actually eat into the rail-posts and boards, staying there until the warmth of the day comes, when they again begin their work of destruction. Is there a remedy to stop this fearful plague and save the crops? Could they be scattered when they commence their inroads on a field, or destroyed on the fences at night?"

"June 26.—Fields have been destroyed by grasshoppers. Pastures are singed as if by fire, and the cutting of oats and fall wheat in the green state has begun in some places. A small red insect is to be found under their wings, which is destroying some

of them, but there are many young hoppers coming in their place. If the present state of things continues much longer, there will be very little of anything left. I fear it is now almost too late to try the hopper-dozer, as the grasshoppers can fly well. Of all the pests this is the worst we have ever seen."—A. Beaton.

"Ashgrove, Halton Co., Ont., Sept. 14.—Grasshoppers this year were very numerous in some sections, but were not so general over the country as I have seen them. In some parts that were stony they appeared at one time as if they would take everything. They were particularly destructive on grass, spring wheat, oats and turnips."—George Hardy.

"Osnabruck Centre, Stormont Co., Ont., Nov. 23.—The worst pests we had to contend with in this section were grasshoppers and Colorado Potato-beetles. With regard to the grasshoppers, they were very bad for a while, but disappeared from this part, as far as I can remember, about August 1st. They were particularly destructive to grain fields adjoining pastures or grass lands."—A. S. Hodgins.

Remedy.—When locusts appear in enormous numbers, they frequently become a serious scourge to the agriculturist. The most efficient remedial measure which can be adopted is the use of the hopper-dozer, which has been described in previous reports. In the case of restricted swarms, much good may be done by the use of poisonous mixtures. As an instance, I cite the following experience :—

"Princeton, Brant Co., Ont., June 23.—I am trying to get rid of the locusts by mixing bran, Paris green and molasses together and putting it in heaps in different parts of a field. Can you recommend any better way of exterminating them? They are doing considerable damage to my crops already.

"July 7.—As to the result of the mixture I used, viz., bran, Paris green and molasses, I applied it in a similar way to that in which the mixture you mentioned in your letter was applied. I put it around six acres of beans which the locusts were destroying as fast as they could. In the next field I had another six acres of beans which were sown a week later. After putting the mixture on the first field the locusts did no further damage to that piece, but started at the beans in the next field. Noticing this, I put the mixture round the second field and they did no further damage to either piece afterwards. I noticed several dead around the heaps and suppose several hopped away to the fences and died there. Whether the poison stopped them eating the beans or whether the beans got too tough for them, I cannot say. Only, I am quite sure they did not bother either lot after it was applied. Alongside of the first lot of beans I had nearly five acres of potatoes just coming out in flower. There we put Paris green on for the potato bug, a few days after putting the poison on the second lot of beans. We then noticed that the locusts were cutting the potato stems off. Some of the stems cut I noticed were a foot in length. When walking through the patch lately I saw hundreds of locusts lying dead. The Paris green was applied to the potatoes mixed with land plaster. At the present time there are millions of grasshoppers or locusts on my farm, and they are doing an enormous amount of damage to my oats. I am afraid it is too late to stop them, although I intend to scatter the poisonous mixture about the fields. My opinion, so far, is that the mixture should be put on, especially on grass land, early in the season before the locusts get their wings and before there is much for them to eat, and continue to apply it at certain intervals."—J. E. Richardson.

From the answers received to the questions sent out by Prof. Panton, grasshoppers were rated as second in the amount of injury caused by insects in Ontario during the past year. There is no doubt but that early in the season there was a considerable amount of damage done by locusts : nevertheless, one of the remarkable occurrences of the year was certainly the widespread and sudden diminution in the numbers of these insects, beginning about the 1st of August.

A curious fact affecting the sudden disappearance of locusts in August last was brought to my notice by Mrs. J. Cunningham Stewart, of Ottawa, who, when travelling on Lake Huron, saw large numbers of grasshoppers floating in the lake. Mrs. Stewart also kindly referred me to Mr. Wm. Lockerbie, engineer of the Canadian Pacific Railway Co.'s steamship "Athabasca," who had observed them on a previous trip. Mr. Lockerbie writes: "As to how numerous these insects were, I can only say they were

collected in patches that would probably cover half an acre or perhaps more, and there seemed to be a very great number of these patches, so much so that when the wind blew off the bay (Georgian Bay), they would float up the Owen Sound River and collect in any shelter that was open." Mr. Lockerbie suggests that they may have been blown off the shore by a high wind.

Judging from a great many letters of correspondents, as well as my own observations, I feel sure that the sudden disappearance of locusts over large districts in Canada was due almost entirely to four kinds of well known parasites—a fungus, intestinal worms, the maggots of two or more species of flies and the locust mite. All of these active friends are well known to entomologists and have been frequently observed before, but, as there has been so much interest evinced in the subject, I give herewith a short account of each, which I feel sure will be acceptable to many.

Grasshopper Parasites.

Fungous Disease of Grasshoppers.—A most potent ally in the destruction of locusts when they exceed their normal numbers is a parasitic fungus known by the name of *Empusa grylli* (Fresenius) Nowakowski. This produces a very infectious disease, the effects of which are frequently observed, but the cause of which is seldom recognized. Diseased locusts were received from Princeton and several other places in Ontario. The disease seems, too, to have been very virulent near Montreal. Mr. T. A. Crane writes from that place, under date of 1st August: "A few days ago the grasshoppers were vigorously attacking my oats. Last evening, when I examined them again, I noticed that they were clinging fast to the tops of the stalks, but they were all dead. Some were minus their heads and some minus their entrails." This describes well the appearance of locusts which have succumbed to this disease.

During the month of August, and later, it was a common thing to see around Ottawa and in almost all other places visited, numbers of different species of locusts, but particularly the Two-striped Locust, hanging motionless, generally near the tips of stems of grasses and other plants. (Fig. 6.) Upon examining these, they were found to be dead and the bodies frequently dried up, brittle and containing a powdery material. This powder is in reality the spores of a parasitic fungus very nearly allied to the well-known and frequently observed *Empusa muscæ*, which every year destroys so many house flies, leaving them dead on windows, curtains, plants, &c., with a cloud-like deposit of the spores of the fungus around them. Under certain conditions, probably much affected by weather—warm, foggy weather being considered favourable—the disease of grasshoppers above mentioned frequently becomes a most fatal epidemic. Each of the mummified bodies is a centre of infection containing myriads of spores, each one of which, blown away by wind or washed down by rain, if it fall upon a locust in a suitable condition, is capable of causing death. This useful parasite, which does such efficient service, had attention first drawn to it by Prof. Herbert Osborn in Iowa, who published his observations, with Prof. Bessey's original description, in *Bulletin No. 2*, Iowa Agr. Coll., 1884, under the name of *Entomophthora calopteni*. The accompanying original illustration, kindly loaned by Prof. Otto Lugger, of the University of Minnesota, shows admirably the attitude of a Two-striped Locust killed by the fungus.

Fig. 6.—Two-striped Locust killed by fungus. (O. Lugger.)

The Tachina Flies.—Mr. J. E. Richardson, of Princeton, Ont., who, I find from several letters received on this subject, is a close and accurate observer, writes:—

"July 7.—I have of late noticed, more especially the other day after a rain, flies attacking the locusts. About half a dozen would fly after one, and as soon as it settled down they would alight upon it."

Prof. Riley graphically describes what this meant, in the *First Report* of the United States Entomological Commission on the Rocky Mountain Locust, page 319: "The most common of the parasites which prey on the locusts internally are the larvæ of certain flies belonging to the genus *Tachina*, gray-coloured, two-winged flies having very much the general appearance of house-flies.

"These Tachina-flies firmly fasten their eggs—which are oval, white, and opaque, and quite tough—to those parts of the body not easily reached by the jaws and legs of their victims, and thus prevent the eggs from being detached. The slow-flying locusts are attacked while flying, and it is quite amusing to watch the frantic efforts which one of them, haunted by a Tachina-fly, will make to evade its enemy. The fly buzzes around, waiting her opportunity, and, when the locust jumps or flies, darts at it and attempts to attach her egg under the wing or on the neck. The attempt frequently fails, but she perseveres until she usually accomplishes her object. With those locusts which fly readily, she has even greater difficulty; but though the locust tacks suddenly in all directions in its efforts to avoid her, she circles close around it and generally succeeds in accomplishing her purpose, either while the locust is yet on the wing, or, more often, just as it alights from a flight or a hop. The young maggots hatching from these eggs eat into the body of the locust, and after rioting on the fatty parts of the body—leaving the more vital parts untouched—they issue and burrow in the ground, where they contract to brown, egg-like puparia, from which the fly issues either the same season or not till the following spring. A locust infested with this parasite is more languid than it otherwise would be; yet it seldom dies till the maggots have left. Often, in pulling off the wings of such as were hopping about, the bodies have presented the appearance of a mere shell filled with maggots; and so efficient is this parasite that the ground in parts of the Western States is often covered with the Rocky Mountain Locusts dead and dying from this cause."

There are several species of these Tachina-flies, and we have bred two kinds during the past summer, one from specimens sent by Mr. Richardson, and another much larger species, *Exorista flavicauda*, Riley (Fig. 7.), from several localities. This last named species is of great interest from the fact that it is the enemy of the Army-worm, which, above all others, brings down the numbers of that plague when it increases unduly. There are also, in addition, parasitic species of flesh-flies (*Sarcophaga*) which resemble the above very closely, but may be distinguished by their antennæ being hairy instead of smooth.

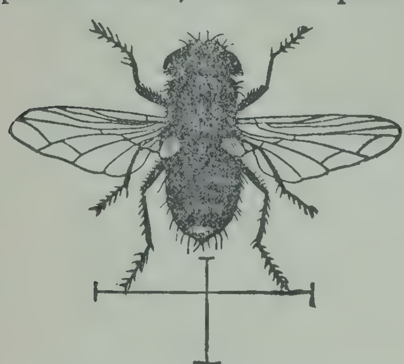

Fig. 7.—Tachina-fly.

Hair-worms.—Hair-worms, or Hair-snakes, as they are sometimes called, are objects of great curiosity, not only to those who know nothing of their habits, but also to all who have studied their remarkable life history. Their great abundance in some places during the past summer has been remarked by many correspondents, and the good work they have done as parasitic enemies of many kinds of grasshoppers, crickets and other injurious insects, renders it advisable to give a short outline of what is known about them. There are many misapprehensions as to the true nature of these creatures, notably the erroneous ideas that they are related to the true snakes or that they are horse-hairs which by some mysterious process have become capable of living and moving. Snakes, however, belong to the much more highly organized Vertebrates, or animals with backbones, while the Hair-worms are members of the Entozoa, or intestinal worms, a section of the Articulates which have their bodies merely divided into joints. The supposition that a horse-hair or any other dead organic matter can ever become a living creature, is too absurd to need more than mention.

Fig. 8.—Egg of *Gordius* containing a fully developed embryo,—highly magnified. (After Leidy.)

It must be acknowledged that there are some gaps in our knowledge of the life history of Hair-worms concerning which it seems impossible to make any suggestion. It is known positively that the eggs (Fig. 8.) are laid in water and that the young worms begin their lives as free-moving animals, which have been actually seen to

penetrate through the delicate skin at the joints of the legs of aquatic insects and live for some time inclosed within a cell inside the bodies of these. The next stage is as parasites in fish, the food of which consists largely of aquatic insects. When the latter containing young Hair-worms are eaten, the cells are broken or dissolved by the process of digestion and the young worms at once work their way, by means of special hooks around the head (Fig. 9.), into the stomach of the fish, where they again become encysted in the mucous layer. After a time they bore through their cells and are passed out from the fish's stomach into the water. Subsequent to this, nothing is known, until they are found as parasites inside insects of various orders, and it is difficult to conceive how it is possible for these worms to enter the bodies of such active insects as locusts and crickets, which also, besides, live mostly in dry places. It is true, though, as has been pointed out, that ground beetles, spiders and locusts which live in low, moist places are most infested. Certain it is, however, that Hair-worms are parasites inside the bodies of many insects, and that specimens have been seen to lay eggs from which young emerged which passed through the stages described above. These worms are of two kinds, which, when only examined superficially, differ chiefly in colour: dark ones, from 6 inches to a foot in length and with a diameter not reaching at the thickest part one twenty-fifth of an inch, belonging to the genus *Gordius*, with the above life history; and others, white in colour, much longer and slenderer, belonging to the genus *Mermis*, which, although similar in their parasitic habits to the *Gordius* worms, have a quite different mode of development, as well as a different internal structure. Both kinds of these parasitic worms are frequently found associated within the body of the same host. The eggs of *Mermis* are laid in the ground and the young on hatching resemble their parents in form. On emerging from the egg they make their way to the surface of the ground and enter at once on their parasitic life in some insect. They acquire full growth inside their host and then bore out through the skin and bury themselves in the ground. It is not until this period in their lives that the genital organs develop. They pass the winter in the ground at varying depths, and eggs are laid in the spring. I received from Mr. T. Pearson, of Knowlton, Que., gardener to the Hon. Sydney Fisher, a large specimen 17 inches in length, which he had found in December under a stone six inches beneath the surface of the ground.

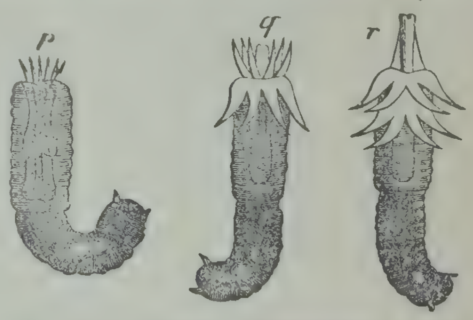

Fig. 9.—Young Hair-worms after escaping from the egg, highly magnified, showing the circles of hooklets (*p*) drawn in, and (*q*) partially and (*r*) wholly protruded.

As stated above, these parasitic worms infest insects of various orders. Mr. W. Hague Harrington, of Ottawa, writes to me:—"I have frequently obtained *Gordius* from locusts, and on one occasion I obtained two small specimens of *Mermis* from a lady-bird *(Hippodamia 13-punctata)*.

In the *First Report* of the United States Entomological Commission is a full account by Prof. Riley of almost all that has been found out concerning these strange creatures. I quote the following:—

"These Hair-worms are not only very frequently found in different locusts, but Prof. Leidy even has one from a cockroach. They likewise occur in many other insects and small animals, as beetles, moths and butterflies, bees, two-winged flies, spiders and snails. As a rule, the worms forsake Lepidoptera while these are in the larva state or more rarely in the pupa state, whereas they generally issue from Coleoptera and Orthoptera only after these have acquired the perfect state."

While they are inside the bodies of their hosts, Hair-worms are folded and coiled up so as to occupy a surprisingly small space. When seen, as is frequently the case, on the ground, they move in a snake-like manner, sometimes with a part of the body raised up and swaying from side to side. When in the water, they are either knotted together and tangled like a piece of black cotton or swimming with an undulated motion close to the surface of the water.

When referred to in correspondence, it is seldom that species of *Gordius* and *Mermis* are separated, though they are frequently mentioned. In no year do I remember so many inquiries to have been made as during the past summer, which, of course, was due

to their unusual numbers. Mr. J. H. Vivian, of Toronto, reports a remarkable occurrence of Hair-worms in Toronto, as follows:—"October 14.—On the occasion when I first saw them there were millions of them both white and dark-coloured. I have a large garden, and it was almost impossible to find a space of two inches between the spots occupied by these worms. A very heavy rain fell on the night preceding. The special peculiarity about them to me was their snake-like movements; standing almost on their tails, they swayed the upper two inches of the body in the air."

During the past autumn they were very abundant, as could frequently be seen on sidewalks where crickets and grasshoppers had been crushed. Sometimes as many as five specimens were found inside a single host. There is no doubt that these parasites materially affect the increase of the insects which they infest, but the statement that grasshoppers so infested never lay eggs is not always at any rate correct. In October last I found a female of the Two-striped Locust which had been trodden upon while laying her eggs between two boards of the sidewalk; upon pulling her abdomen from between the boards, I found she had laid five or six eggs and the abdomen contained several more ready to be laid, and also one specimen of *Gordius* and two of *Mermis*.

The Locust Mite.—The parasite of grasshoppers which has probably been most frequently noticed and which has been very widespread during the past summer, is the small red mite, *Trombidium locustarum*, Riley, which, in its larval form, is often a conspicuous object on the bodies of grasshoppers. The larvæ are small, bright red, bag-like, six-legged mites (Fig. 10*a*.), most frequently found attached,

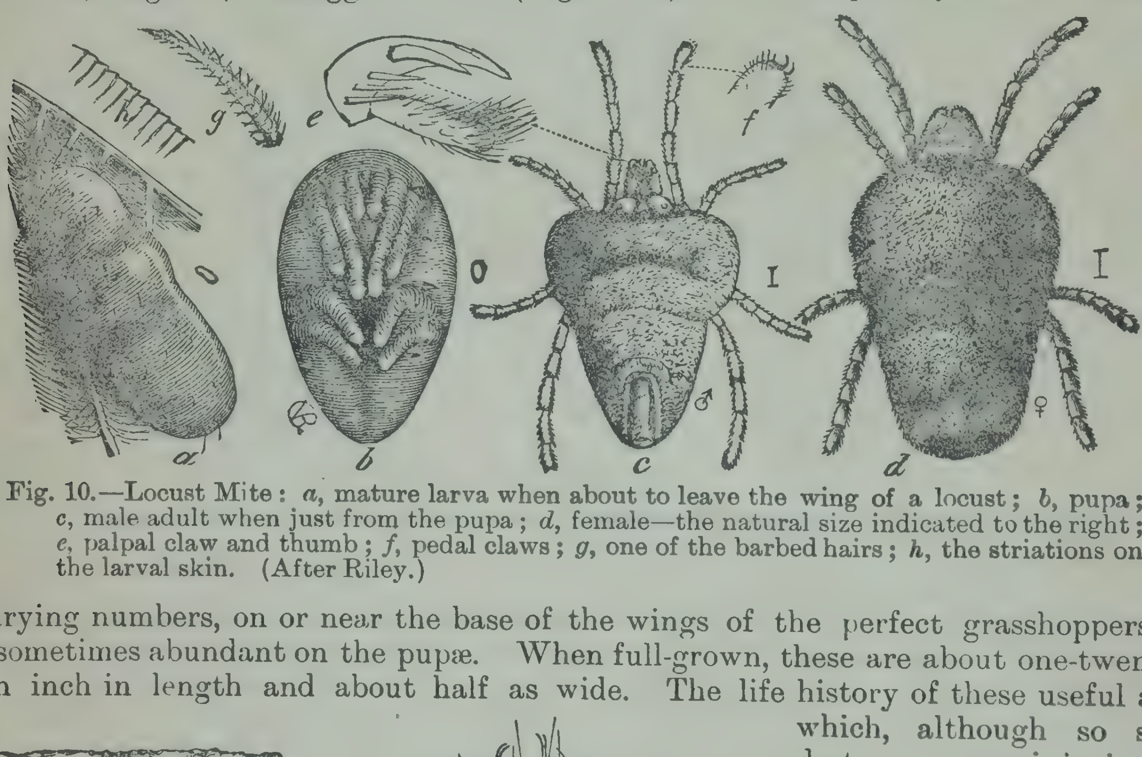

Fig. 10.—Locust Mite: *a*, mature larva when about to leave the wing of a locust; *b*, pupa; *c*, male adult when just from the pupa; *d*, female—the natural size indicated to the right; *e*, palpal claw and thumb; *f*, pedal claws; *g*, one of the barbed hairs; *h*, the striations on the larval skin. (After Riley.)

in varying numbers, on or near the base of the wings of the perfect grasshoppers, but also sometimes abundant on the pupæ. When full-grown, these are about one-twentieth of an inch in length and about half as wide. The life history of these useful allies, which, although so small, destroy many injurious locusts, has been worked out fully by Dr. Riley. The eggs are laid in spring in clusters of between 300 and 400, an inch or two beneath the surface of the ground. From these eggs hatch little orange red mites (Fig. 11*b*.), which, being very small, crawl out easily between the particles of the soil and fasten themselves to their future hosts, generally selecting a spot near the base of the wings from which they

Fig. 11.—Locust Mite: *a*, female with her batch of eggs (after Emerson); *b*, newly hatched larva—natural size indicated by the dot within the circle; *c*, egg; *d*, *e*, vacated egg-shells. (After Riley.)

cannot be dislodged. Sinking their minute jaws into the tissues of the body of their victim, they remain firmly attached, sucking its blood and living entirely at its expense, until the full larval growth is reached. Dr. Riley thinks that the full period of development of the larvæ, after attachment, seldom exceeds a fortnight. When distended with food, these mites are so swollen that their short legs are almost invisible, and many people who notice them mistake them for the eggs of some parasite. When examined closely, however, their legs can be seen and are found to be six in number, which is now known to be one of the characters of the larvæ of the genus of mites called *Trombidium*. As soon as the larvæ are full-fed, they let go their hold of their hosts and fall to the ground, where, under some temporary shelter, they gradually change to pupæ inside the larval skin. Finally, both the old larval skin and the new one inside it, which incased the pupa, burst, and the perfect form, an eight-legged mite, emerges. These are common objects in the country, drawing the attention even of people who do not study insects, by the intensity of their velvety scarlet colour. They pass the winter in the perfect state, and are frequently conspicuous on the ground in early spring before vegetation has made much growth. Not only is this insect useful in the larval form, when it preys upon locusts, but also in the perfect state it does good service by seeking out and devouring their eggs.

I give below a few extracts from letters of correspondents who have noticed these mites :—

"Craighurst, Simcoe Co., Ont., Dec. 19.—We had this year the same experience with grasshoppers as you mention. They hatched out in immense numbers, and at one time we were afraid they would do great damage, but they seemed to disappear early in August or the latter part of July. The parasite that lays its eggs on their backs under the wings was abundant. Most specimens examined showed their presence."—G. C. CASTON.

"Princeton, Brant Co., Ont., June 23.—On examining some locusts or grasshoppers, I find on the underside of the wings some minute insects—I suppose, parasites. They are now on nearly all the locusts I have looked at. The majority are about $\frac{1}{20}$ of an inch in length, but many much smaller, of a bright red colour."—J. E. RICHARDSON.

"Doe Lake, Muskoka, Ont., August 18.—Grasshoppers damaged both grass and grain. They have done much harm on light sandy soil ; there are many of the red eggs under the wings. Are they parasites ?"—F. C. JUDD.

"Omemee, Victoria Co., Ont., Aug. 3.—I send you a common grasshopper, with red insects on it. They appear to be very numerous this year, but I fear came too late to prevent the grasshoppers doing harm."—E. S. MORGAN.

"Louise, Grey Co., Ont., September 26.—Grasshoppers came along about the 1st of June in massive flocks and destroyed nearly all the hay. They were by far worst on spring wheat and barley ; in fact, there was hardly any of either grain in this part. Oats turned out about 10 to 12 bushels per acre. Pease were a fair crop. The hoppers all disappeared about the 1st of August."—GEORGE LAST.

"London, Middlesex Co., Ont., December 7.—I never saw grasshoppers worse than in a part of McGillivray about the middle of June, but within two or three miles on each side they were scarce. Where they were very numerous, I found none of the locust mites ; where scarce, almost every one was infested."—J. DEARNESS.

THE GRAY BLISTER BEETLE.

No account of the common parasitic enemies of grasshoppers would be complete without some mention of the Blister Beetles, which in their larval stage prey upon the eggs. During the past summer, as is usually the case in years following excessive locust presence, Blister Beetles have done considerable damage to potato and bean crops and several kinds of garden plants.

"Grenville, Argenteuil Co., Que., June 11.—I send by mail specimens of a new (to me) potato pest. On a potato patch 20 feet by 40 feet there were many thousands of them. I was through the patch two days ago, and there was no appearance of anything unusual. Now the plants on which they are feeding are almost leafless."—ROBERT HAMILTON.

"Staynerville, Argenteuil Co., Que., June 18. I have a field of horse beans which came up and are growing nicely, but during the last two or three days a kind of bluish fly is stripping off every leaf."—Wm. Nichols.

"Chêneville, Labelle Co., Que., June 16.—I send you some insects which are in very large numbers on my potatoes, eating the leaves rapidly. I have sprayed the plants with a mixture of 1 pound of Paris green in 200 gallons and the insects are already disappearing."—H. Lefebvre.

Specimens were also sent from Mr. L. Lepage, from Minerve in the same county.

"Port Arthur, Ont., June 23.—I mail you herewith insects captured on a potato patch near Port Arthur, wherein they were stripping the vines of their leaves. These are apparently a far worse destroyer than the Colorado Potato-beetle. This is the first time an enemy of the leaf of the potato has appeared in this district."—Joseph G. King.

"Montreal, Que., June 25.—I send you beetles which did a little harm on my farm last year, and this year they have done a good deal. Their preference seems to be for tender, delicate foliage, but when this is not handy they take what they can get. They began with *Caragana gracilis*, *Aralia spinosa* and *Clematis flammula*, and ended with potatoes and tomatoes. They come in hundreds and make a clean sweep of any branch they attack."—Thos. A. Crane.

"Montreal, Que., June 24.—I send specimens of a beetle which attacks the Windsor Broad Beans. We have grown these beans for three years at Lachine. The first year they produced well, the next year this beetle pest appeared in swarms and ravaged them severely. Tired of picking them off, we tried a weak mixture of Paris green, with flour or water, I forget which, but it killed the crop and we did not have a dressing. This year we have more beans growing than usual, but they have been attacked incessantly by the pest which is a voracious eater. A neighbour not knowing our experience tried Paris green and killed his plants. We have been picking and knocking the pests off into a mixture of coal oil and water in a broad, shallow vessel, which seems to kill them. Last year a small cloud of them settled down on the potato vines and ate to some extent, but did no damage. This year they have left the potatoes alone for the beans. They do not breed in our place, but settle down in small swarms, full-sized, and it seems to us that nothing but a strong mixture, dangerous to the plant, would kill them, but perhaps you can tell us a remedy. It is necessary to pick them off at least once a day (earlier in the season, perhaps oftener), but they are not diminishing much. The labour is so tiresome that we shall be little disposed to grow our favourite bean another year, and others no doubt feel the same."—A. H. Chambers.

"Previck Hall, Port Arthur, Algoma, Ont., Sept. 5.—In July my horse beans were infested with black beetles which I have sometimes seen on potatoes. I do not think they have podded quite so well. I did not dare to use poison for the beetles, as it would have spoiled the fodder. I killed as many as possible by hand, but they stripped many stalks of the leaves."—William Wilson.

"Petitcodiac, Westmoreland Co., N.B., Dec. 9.—The black blister beetles were on my horse beans in about the same numbers as last year."—D. Sinclair Smith.

All the specimens sent in this year were the gray blister beetle (*Macrobasis unicolor*, Kirby). Here on the Experimental Farm the same species was abundant and troublesome on Caragana hedges, some other leguminous shrubs in the botanic garden and *Aralia chinensis*, L. Although the attack is severe while it lasts, the period during which blister beetles injure vegetation is not of long duration. Moreover, these insects do not appear in injurious numbers every year. They are seldom noticed except in seasons following those when locusts of different kinds have been unusually abundant, a fact which is easily understood when we remember that the larvæ feed upon the eggs of locusts. For the same reason we may confidently hope that next year we shall have little complaint of the ravages of blister beetles on beans and other crops, owing to the marked diminution in the numbers of grasshoppers after the 1st of August last. In localities liable to be visited by blister beetles a sharp watch should be kept for their appearance during July, and as soon as they are seen efforts should be made to fight them, either by sweeping the crops with a net mounted on a handle or by beating them into a pan containing some

water, with a little coal oil on the top. When the area attacked is too large for this, spraying promptly with Paris green, one pound to 100 gallons of water, or dusting with one pound of Paris green to 50 of flour, would destroy them.

Referring to Mr. A. H. Chambers's experience above mentioned, I think there must have been some other cause than the Paris green which destroyed his crop, for a very much stronger mixture than he mentions has been used by some of my correspondents and by myself without injury on the same crop.

Locusts on Sable Island.

In my reports for 1894 and 1895 I have referred to serious injury by locusts on Sable Island, off the coast of Nova Scotia. This was so severe last year that it was necessary to purchase 50 tons of hay to keep the horses and stock through the winter. During the past summer the loss has been far less. The Superintendent of the island writes: "September 7.—In a few days we shall have finished harvesting the hay crop, which this season is large, owing to the unusual continuous fogs and heavy rains from June till the middle of August. The locusts have done but little damage, although plentiful. Vegetation nearly everywhere kept ahead of them." In an earlier letter dated the 12th of June, the Superintendent expressed the opinion that hopper-dozers could not be used satisfactorily on Sable Island, owing to the uneven surface and loose sand in places. He invested in turkeys and raised a large number of chickens, which doubtless were useful in destroying many locusts. The young locusts first appeared at No. 4 Station about the 24th of May, but none appeared at Main Station until the 12th of June.

ROOT CROPS AND VEGETABLES.

Few complaints of injuries by insects to root crops during the past season have been received. There were, of course, the usual applications for remedies against the Turnip Flea-beetle (*Phyllotreta vittata*, Fab.) from all parts of the Dominion, but the loss was not extensive. The best remedy—dusting the young plants as soon as they appear with land plaster and Paris green (50 to 1)—is now well known. During June this insect, both in the mature and larval forms, was troublesome in gardens at Ottawa upon cress, particularly the curled varieties. When the plants were young, a mixture of Paris green and flour was used successfully; but later, when the crop was ready for the table, dusting with powdered tobacco waste was substituted, and the cress was kept closely picked. The larvæ, which are slender, dark brown grubs, dotted with black, are from one-eighth to three-sixteenths of an inch long, and for the most part mine inside the tissues of the leaves, but frequently, when nearly full grown, burrow out through the thin epidermis and feed for a time on the surface. I have been unable to find these feeding, either on or in the roots. When full-fed they enter the ground, sometimes to a depth of three inches, and emerge nearly three weeks later as the well known perfect flea beetles, which are about one-eighth of an inch long, with two wide waved yellow stripes down the back. As a rule, the larvæ are not often noticed, because by the middle of June the demand for garden cress as a salad or table relish has ceased, owing to the abundance of radishes and similar vegetables. Injury to the leaves at this time is, therefore, of small importance, as the larvæ are never abundant enough to affect the formation of seeds on such plants as are left for that purpose. When green leaves are required, the best method is to encourage a quick growth by watering frequently and cutting as soon as the leaves are fit for use. A weak solution of nitrate of soda (one ounce in three gallons of water) applied carefully to the roots twice a week was found to be a quick-acting stimulant. In this way succulent leaves are produced abundantly before the larvæ have time to develop. When, however, a bed is badly infested, the only plan is to cut the whole bed and water freely; the new growth will also start more quickly if the beds are shaded.

In the North-west Territories and Western Manitoba the RED TURNIP BETTLE (*Entomoscelis adonidis*, Fab.) did some harm to cabbages and turnips, but the beetles were easily disposed of where Paris green was applied.

The STRIPED CUCUMBER BEETLE (*Diabrotica vittata*, Fab.) was the cause of much loss on melons, squashes and cucumbers in several parts of Ontario. The injury is done by the perfect beetles to the flowers and leaves, and by the grubs to the roots in which they burrow. The remedies which have given the greatest satisfaction are dusting the plant with Paris green and dry ashes (1 to 50) or covering them, until the runners are produced and the plants become too large, with a piece of gauze or cheese cloth, supported by two or three sticks stuck into the ground, and with the edges held down by a handful of earth on each side. This means of protection was first suggested by Dr. Clarence Weed in a bulletin of the Ohio Experiment Station for September, 1889, and has been used with much success by some of my correspondents, particularly in garden culture. For preventing egg-laying and also for killing the young larvæ, putting a small quantity of tobacco dust or sand, impregnated with coal oil, close round the base of the stems, is useful if the gauze covers above mentioned are not used.

THE CLOVER CUT-WORM (*Mamestra trifolii*, Esp.).—During the month of August I received from a few localities in Peterborough county, Ont., specimens of caterpillars of the Clover Cut-worm, with the information that they were damaging pease and turnips severely, and some other crops. They were so numerous that they had assumed the Army-worm habit of marching from field to field in search of food. The Clover Cut-worm is a thick, green, smooth caterpillar with black or gray markings extremely variable both in the depth of the ground colour and the shape and extent of the markings, some specimens appearing to be all green, while others have the dark markings so extensive as to cover the whole of the upper surface. Length, about one and a half inches. A more exact description of the full-grown caterpillar is as follows :—

"A dark-green noctuid caterpillar with a very narrow dorsal stripe, a broken sub-dorsal stripe of yellow, edged above by velvety black blotches (the black line not quite as continuous as the yellow); below the breathing pores, a broad pink band, narrowly edged with white above and below. Above the upper white line is a black one which spreads out into a black blotch around each spiracle. The whole body mottled with white on a smooth green surface, giving a somewhat glaucous shade to the green. The narrow dorsal stripe consists of an aggregation of these mottlings, and the dorsal space has them shadowed with black, giving that area a darker appearance than the rest of the body. Legs and pro-legs green, like the body. Head green, bearing on the upper part of the face and on the cheeks clouds of white mottlings. Some of these caterpillars were simply pale green with fuscous markings, others were green, with clear brownish or black markings, some had the mottling all over the body so shaded with brown as to suggest the appearance of the Army-worm. Specimens intermediately tinted between all these colours occurred."

"Birdsall, Peterborough Co., Ont., August 10.—By this day's mail I send you a box with half a dozen worms that have nearly destroyed a field of pease for me. Kindly tell me the name of them, and if it would be safe to sow the field with fall wheat next month, or would they be apt to come and destroy it next year or this fall? The ground is nearly covered with them. They first appeared about two weeks ago. They have destroyed several patches of turnips in the neighbourhood. I also send you a sample of the pea vine as partially eaten by them.

"August 17.—Thanks for your prompt answer to my letter in regard to the caterpillar. It may be as you state, that the damage to the pease will not be as great as I at first expected, as they hardened up so quickly that the worms had to leave. They all started off in a south-eastern direction and will by this time have all fallen into the river or lake. They have not attacked my turnips, as they are to the west of the field, but many of my neighbours to the north and west are having their turnips destroyed by them."—F. BIRDSALL.

"Birdsall, Peterborough Co., Ont., November 25.—The turnips injured grew right besides a field of pease, and for a time we thought some new insect pest had made its appearance, but when we came to cut the pease the mystery was explained, as they were

evidently the same kind of caterpillars as are always found on pease; only, this year they were very much more numerous than usual and crossed over from the pease to the turnips. The green leaves near the ends of the pea vines and the ends of the vines themselves were eaten, but the pease were too nearly ripe when they were attacked to be injured much. I never before saw anything like it. The ground was literally alive with the crawling insects. We put Paris green on the turnips, and this doubtless helped, but the insects were so numerous that one set after another took the place of those killed. The turnips near the pease were injured most and as you receeded from the edge of the pease the injury lessened. The turnips put forth a new set of leaves, but the growth of the roots were stunted and they were only about half a crop. There seemed to be about half a dozen different kinds of caterpillars. I could see no difference between some of them and the ordinary cabbage worms. Then there were all shades of green and brown with various markings, some with two rows of yellow stripes, others with two rows of yellow dots along the back, others with black dots, and some simply a shade of green, brown or black. I did hear of caterpillars being plentiful in some parts of adjacent townships, but in this immediate neighbourhood I do not think the injury caused by them was very great. They were on no crops near here, only pease and turnips, and the turnips alone were greatly injured."—ROBERT TUDHOPE.

"Villiers, Peterborough Co., Ont.—The green caterpillar which destroyed our turnips did not touch our pease, but there were thousands of them on turnips and carrots, doing much injury. One of my neighbours, Mr. James Fife, says there were millions on his turnips and carrots, injuring the crop about half. Mr. George Webber used Paris green on his turnips, but with little effect, as the numbers were so great."—PHILIP W. ELMHIRST.

Remedies.—When these caterpillars assume the habit of the Army-worm of marching from field to field, ploughing a deep furrow across their path is a useful check. If sufficiently abundant, as will rarely be the case, to fill up the furrow, they may be easily destroyed by dragging a heavy log over them. When they occur on roots and other crops, the only practical method of destroying them is dusting or sprinkling the plants with a Paris green mixture. Ploughing late in the autumn is also recommended. As the Clover Cut-worm passes the winter in the chrysalis stage inside a slight cell a short distance beneath the surface of the soil, late ploughing will disturb many and expose them to the frost and to predaceous enemies.

THE ZEBRA CATERPILLAR (*Mamestra picta*, Harris).—A good many letters of complaint have been received concerning the work of the well known Zebra Caterpillar, which was abundant in the eastern parts of Ontario. There are two broods of this insect every year. The moths of the first brood issue from the chrysalis during May and lay their eggs in large clusters on the under sides of leaves of many different plants. These hatch in a little more than a week, and the young caterpillars for a time feed gregariously, devouring all the green cellular portion and making large conspicuously white patches on the leaves. As they grow larger, they separate and feed singly. The caterpillars of the first brood are full grown about mid-summer, when they are large caterpillars, two inches in length, beautifully ornamented, velvety black on the back, with two golden yellow stripes connected by narrow white lines along the sides. The head, thoracic feet and pro-legs are bright reddish brown. When full-grown these caterpillars spin slight cocoons just beneath the surface of the ground and the moths emerge about the first week in August; they are rather dull-coloured, purplish-brown moths, with white under-wings, expanding about one and a half inches across the opened wings.

The eggs for the second brood are laid throughout August and into September, and the caterpillars are to be found, as a rule, later than those of any other of our moths. Being conspicuously coloured, they are often noticed crawling about looking for food late in the autumn when most kinds of plants have been frozen and killed. The winter season is passed in the chrysalis state beneath the ground.

The crops most attacked by the Zebra Caterpillar last season were pease, and particularly sweet pease in gardens, turnips, clover, potatoes and cabbages. In addition to these, however, these insects levied heavy toll in the flower garden attacking indiscriminately almost all annuals. The eggs and clusters of young caterpillars of the second

brood were found in remarkable numbers at Ottawa during August on lucerne, and on lily and gladiolus leaves.

The eggs were much infested by two minute parasites, *Trichogramma pretiosa*, Riley, and *Telonomus* sp., noticed in the same connection in 1892, and the young caterpillars were also destroyed by an *Apanteles* which occurred both at Ottawa and at Birdsall, Ont.

"Birdsall, Peterborough Co., Ont., August 18.—There are two kinds of caterpillars which are doing a good deal of harm on my turnips, a green one and a yellow and black striped one. I suppose a little of the Paris green and plaster mixture would be the best thing for them. Kindly let me know if you think there would be any danger in feeding roots so treated to stock."—F. BIRDSALL.

"Omemee, Victoria Co., Ont., August 18.—I send you some striped caterpillars which I find in numbers on the turnips, a great many together on a single leaf; they seem to eat the upper surface principally. There are with them, also abundant but occurring singly, some green ones which eat the edges of the leaves, No. 2, and besides a few of the smooth green ones with dark marks, No. 3, which feed like No. 2."—E. S. MORGAN.

The green caterpillars mentioned by Mr. Birdsall and the No. 2 of Mr. Morgan's sending were those of the small White Cabbage Butterfly (*Pieris Rapæ*, L.). Mr. Morgan's No. 3 were specimens of the Clover Cut-worm (*Mamestra trifolii*, Esp.).

"Peterborough, Ont., September 3.—The inclosed worm is very abundant in this neighbourhood this season; it feeds on the leaves of turnips."—J. A. FIFE.

Remedies.—The best remedy for these caterpillars is spraying or dusting with arsenical mixtures, but they seem to be rather resistent to the action of those poisons generally used, such as Paris green. Mr. T. W. Ramm, of Ross Mount, Northumberland Co., Ont., writes: "You know the yellow-striped caterpillars of *Mamestra picta* which are sometimes plentiful on pease. It took almost two days to kill some of these which were on pease, although I almost buried them in dry Paris green of full strength tested with ammonia and then it destroyed the pease as well." A weaker mixture distributed evenly over the food plant would probably have been more fatal to the caterpillars without injuring the pea plants—1 lb. of Paris green to 200 gallons of water or to 50 lbs. of dry land plaster was quite satisfactory at Ottawa.

No danger need be apprehended from feeding roots to stock which have been dusted or sprayed with Paris green mixtures. There are always several weeks—and this at a rainy season of the year, too—between the time that this is likely to be necessary and when the roots are fed to stock. If there is any doubt, however, about all the poison being washed off the roots, the tops can easily be cut off closer to the root than usual, which will remove all possibility of danger. The poison could only lodge in the axils of the leaves, of which a clean sweep will be made when the leaves are cut off.

Owing to the gregarious nature of the caterpillars when young, good work can be done in August and September by picking off the leaves bearing the young broods and destroying them.

SMALL WHITE CABBAGE BUTTERFLY (*Pieris Rapæ*, L.).—It will be noticed in the above extracts that this insect was twice mentioned as injurious to turnips. There were other reports of the same nature, but the chief injury mentioned by correspondents was to cabbages. There are few insects more easily controlled than this, if prompt action be taken at the proper time.

The best remedy for this insect, as far as my experience goes, is undoubtedly pyrethrum powder diluted with four times its weight of common flour and then kept in a tightly closed vessel for twenty-four hours until the poisonous principle has permeated the whole mixture. If a small quantity of this mixture be dusted over infested plants, the caterpillars are all destroyed, and in a surprisingly short time. Pyrethrum or insect powder kills by contact, both in a dry condition and as a decoction, so that such caterpillars as are not actually reached by the powder are destroyed by the poisonous principle of the pyrethrum carried farther among the leaves by rain or condensed dew. This remedy is so effective and so cheap that I do not think it well to recommend any other.

It has also the very great advantage of being perfectly safe, because, although so fatal to all insects, it has no poisonous effect on man and the higher animals.

The COLORADO POTATO-BEETLE (*Doryphora 10-lineata*, Say) seems to be, on the whole, the most troublesome farm insect in the country. Prof. Panton, of Guelph, Ont., expresses the same opinion in his report on answers received to the questions he had sent out to the farmers of Ontario as to which were, in their experience, the insect pests most injurious to farm crops. In most places, however, growers have generally adopted the easy and cheap means of keeping it in check by spraying or sprinkling the potato plants with Paris green mixed with water or some dry powder as a diluent. This remedy, when applied with ordinary care, answers its purpose most effectively.

"The potato-beetle was reported as numerous by some correspondents, while others stated that it was not nearly so bad as usual."—*Ontario Crop Report, Aug. 13.*

"Point de Bute, Westmoreland Co., N.B.—The potato-beetle did less damage this season than last."—HOWARD TRUEMAN.

"Alberton, P.E.I.—The Colorado beetle came out of winter quarters later than usual this spring and many were congratulating themselves that it would not show itself, but it soon got to work, and if the potatoes were late in coming up, it stood right by, waiting their arrival, utilizing the blades of grass for egg laying in the meantime. Good Paris green saved the crop. Farmers have improved ways of 'greening' now. As a general thing, a cask on a cart or truck, provided with a sprinkler at each side, thus covering quite a number of drills at a time, made the work light. The acreage under potatoes is restricted now. A farmer seldom plants more than a couple of acres. They are low-priced, and the bug has raised the cost of production. I really think, though, that this bug is running its course."—REV. A. E. BURKE.

"That great potato pest, the Colorado potato beetle, seems to be much less dreaded than formerly. It seems to have been well kept in check by the use of Paris green, either sprayed on the vines or dusted on after being mixed with gypsum or land plaster."—*Nova Scotia Crop Report, November.*

According to the notes from the different districts of Nova Scotia, contained in the above crop report, the potato-beetle was particularly troublesome in the north-western counties, but much less in the others.

"Yarmouth, Yarmouth Co., N.S.—I have not yet seen a potato-beetle in my county. A few have appeared in widely separated localities since 1893, when the first were noticed, but this is the fourth year since, and there has not been at any time a marked increase in serious injuries from them in this county."—CHARLES E. BROWN.

"Glace Bay, Cape Breton, N.S.—Insects this season did much less damage to vegetation. Chief among them is the Colorado Potato-beetle, which made things pretty lively for the farmers round my home. Some used Paris green, others hand-picked them. The beetles do not seem, however, to be so numerous as at first."—JAMES W. EDWARDS.

"Upper Baddeck, Victoria Co., N.S.—The potato bugs were very plentiful. I did not learn that any in this district used Paris green, as they are somewhat afraid of its poisonous effects. We, however, find that if we commence early, when the beetles first show themselves, to spray the fields carefully three or four times in as many weeks, it leaves them powerless to do much injury when the vines get strong."—ALLAN MCMILLAN.

"Berwick, King's Co., N.S.—The potato bug has become so general that it is taken quite as a matter of course, and the farmer expects to use Paris green quite as much as he expects to plant his seed."—S. C. PARKER.

CUT-WORM injuries in garden and field crops have this year been frequently reported. The most severe depredations were committed in New Brunswick, Nova Scotia and in Alberta District; strange to say too, it was by the same species the Red-backed Cut-worm (*Carneades ochrogaster*, Gn.). It is seldom that correspondents trouble to send in cut-worms, but when this was done, in almost every instance, the species was found to be the above which gave trouble during the spring of 1896. Although there are so many different species of cut-worms, their general habits are now so well known that a wide-awake gardener or farmer can by prompt attention and a little trouble, as a rule,

do a great deal to prevent serious loss. Cut-worms are the caterpillars of dull-coloured active moths belonging to the *Noctuidæ* or Owlet Moths (Fig. 12), of which there are upwards of 400 different kinds in North America. The caterpillars of these different kinds vary somewhat in their habits, but, on the whole, they are very similar, being smooth, almost naked, gray-looking caterpillars (Fig. 13) of some dull shade of colour similar to the ground in which they hide during the day. The head is smooth and shining as well as a small horny plate on the segment next to the head. Their habits are almost always nocturnal; lying hid by day just beneath the surface of the soil, they come out at night to feed. When they occur in large numbers, they change their habits somewhat and feed by day as well, owing to the reduced food supply consequent upon their ravages. The eggs from which cut-worms hatch are laid by some species in the autumn and by others in the spring or summer and, as a consequence, cut-worms of all sizes can be found in the spring; for these insects, according to the species, may pass the winter in the state of either a perfect moth, a chrysalis, a partially grown caterpillar, or an egg. This last habit is that usually, if not always, followed by the Red-backed Cut-worm. Eggs laid in Ottawa in October did not hatch until the end of the following April, and the caterpillar took 6 weeks to reach full growth; they were then large cut-worms over $1\frac{1}{2}$ inches in length, gray, with a broad sienna-red stripe down the middle of the back. The moths did not emerge until 5 weeks after the caterpillars buried themselves to turn to chrysalids. This cut-worm is particularly injurious. It is a large voracious species with an exceptionally wide territorial distribution and feeds upon almost all kinds of succulent vegetation. Nearly all the references in the following extracts were to the Red-backed Cut-worm.

Fig. 12.—A Cut-worm Moth (*Agrotis clandestina*).

Fig. 13.—A Cut-worm (*A. clandestina*).

"Edmonton, Alta.—Cut-worms as busy as ever in the Peace River District."—C. BURTON.

"Edmonton, Alta., June 16.—Everbody about here is troubled with cut-worms, which have done great damage, necessitating the sowing of gardens over again."—FRANCIS C. CLARE.

"South Edmonton, Alta., July 13.—I send you a box containing cut-worms. They are most destructive, cutting off cabbage and all root crops just under the ground. If you remove the earth from a bitten off plant, you find the grub buried just beneath. They are general throughout this district."—I. L. ANDREWS.

"Lacombe, Alta.—I tried alsike clover here; it came up splendidly; but the ground was so full of cut-worms that they took almost the whole of it, although I sowed about six acres."—HARRY SARGENT.

"Cochrane, Alta.—This summer for the first time cut-worms were very bad on my cabbage crop; they cut the plants off close to the ground."—JOHN DARTIGUE.

"Calgary, Alta.—I have a fair-sized vegetable and flower garden here. This spring my garden swarmed with cut-worms, as did gardens of others in the neighbourhood. The worm is just the colour of the soil; it burrows into the ground by day and comes up at night to feed. These insects gave no trouble after the first or second week of June. I had to plant three crops of every thing before I could get the start of them. The vegetables the worms went for were onions, beets, parsnips, carrots, peas, beans, turnips, radishes, lettuce. Can you advise me what to do to rid my garden of this pest?"—E. D. H. WILKINS.

"Victoria, B.C., June 12.—Cut-worms have been hard at work about Victoria. One grower lost all his onions, and I have heard complaints from many others."—J. W. TOLMIE.

At the same time specimens were also received from Mr. Mont. McDonald, of the same place.

"St. John, N.B., May 27.—Please send me some information about cut-worms. Last year in the garden at my summer house out of town we were very much troubled

with them. It seems impossible to destroy them. Can you give us a remedy?"—W. WATSON-ALLEN.

"Sussex, N.B.—Cut-worms in the spring were a terrible pest, and several men who make a habit of growing some hundreds of barrels of onions in this section were unable to grow any at all."—W. W. HUBBARD.

"Fredericton, N.B.—We had a regular plague of cut-worms last spring. Our root crops, and to some extent the corn and grain, were much damaged by them. I knew a field that was re-seeded four times."—PERCY C. POWYS.

"Petitcodiac, N.B.—The cut-worm is our worst enemy and is worst on sod, even if ploughed fall and spring."—B. SINCLAIR SMITH.

"Halifax, N.S., June 27.—How can I destroy cut-worms? It is impossible to grow anything in some lands in this neighbourhood, even in newly turned up soil. They are destroying my ensilage corn."—R. HUNT.

"Berwick, King's Co., N.S.—Cut-worms were very destructive in Nova Scotia this summer; many fields of beans, turnips, cabbages and tomatoes were much injured. Our cabbage and tomato crop was only saved by wrapping the stems with paper as the plants were set."—S. E. PARKER, *Secretary, Fruit Growers' Ass., N.S.*

"Nappan, Cumberland Co., N.S.—Cut-worms bothered us a good deal, but were extremely destructive in Yarmouth Co."—W. S. BLAIR.

"Yarmouth, Yarmouth Co., N.S.—Cut-worms abounded throughout the county, destroying successive sowings of vegetable crops. They are estimated to have reduced mangels by 15 per cent."—C. E. BROWN.

"Bear River, Digby Co., N.S.—Cut-worms did a great deal of harm in the spring to all kinds of vegetables."—R. G. TURNBULL.

"Chester, Lunenburg Co., N.S.—Cut-worms destroyed gardens."—E. D. LORDLY.

In the Nova Scotia *Crop Bulletin* for November, 1896, cut-worm injuries are recorded in the counties of Digby, Lunenburg, Pictou and Yarmouth.

"Alberton, P.E.I.—We were much troubled with cut-worms in our gardens in late May and June. Some people lost all their young vegetable plants, having been, I think, too careful to pull out all the weeds early. The dry weather suited the worms. At night in June and July you could hardly see out of the windows from the numbers of the clumsy brownish gray moths of this pest."—REV. A. E. BURKE.

Remedies.—The remedies for cut-worms are active or preventive. The chief active remedies are, poisoning the caterpillars, which may be done effectively in two ways, or hand-picking:

1. Traps.—Large numbers may be destroyed by placing between the rows of an infested crop, or at short distances apart on infested land, bundles of any succulent weed or other vegetation which have been previously poisoned by dipping them into a strong mixture of Paris green (2 ounces to a pailful of water). The cut-worms eat the poisoned plants then they bury themselves and die. In hot dry weather these bundles should be placed out after sun-down, and a shingle may be laid on each to prevent fading.

2. Poisoned Bran.—Striking results have been obtained during the last two years by putting along rows, or at the base of such plants as tomatoes and cabbages, a small quantity of the following mixture which is mentioned in Prof. J. B. Smith's excellent new *Manual of Economic Entomology*:—

Thoroughly mix together in a dry state 50 pounds of bran and 1 pound of Paris green; then add water a little sweetened with sugar until the whole is thoroughly wet but not sloppy. Prof. Smith says: "This mixture is extremely attractive to cut-worms, being preferred to plants in all the instances which have come under my notice. It takes about ten pounds of this mixture to an acre of potatoes as ordinarily planted."

The same mixture has been used dry by Mr. F. A. Sirrine of Geneva, N.Y., with, he claims, even better results than the wet mixture, which is apt to get mouldy.

3. Hand-picking, or digging up the cut-worms whenever a plant is seen to be cut off, should, of course, always be practised.

Preventive remedies consist of:

4. Clean culture, by which all vegetation is removed, upon which the young caterpillars could feed in the autumn or which would attract the moths to lay their eggs.

5. Banding.—Cut-worms are heavy-bodied insects unable to climb over smooth surfaces; therefore, surrounding a plant or tree with a band of tin or even of paper in the case of such plants as cabbages and tomatoes is an effective means of protection. Tin bands may easily be made by taking pieces of tin six inches long by two and a half wide and bending them around a spade or broom handle so as to form short tubes. In placing them around a plant, the two ends can be sprung apart to admit the stem and then the tube should be pressed a short distance into the ground. I have found this a useful means of disposing of tomato and other cans. To prepare these easily the cans need only be thrown into a bon-fire, when the tops and bottoms fall off and the side becomes unsoldered. The large piece of tin can then be used whole or may be cut down the centre with a pair of shears so as to form two bands. It may be well to mention here that the two remedies so often recommended in newspapers, salt and lime, have proved quite worthless in our experiments for preventing cut-worm injuries.

FRUITS.

The fruit crop of Canada, particularly of apples, has this year been enormous, and compared with other years, there has been little complaint of insect injuries. Wherever spraying with Paris green, either alone or mixed with fungicides, has been practised, marked results have been obtained. These would, of course, have been much more noticeable in a year of less abundant fruitage. It is to be regretted that this most useful means of saving money is not more universally adopted by the fruit growers of the Dominion.

Two new pests of the apple, the Apple Fruit-miner in British Columbia, and the Apple Maggot in Ontario, have demanded attention on account of their injuries during the past season. These are treated of at some length later.

The CODLING MOTH (*Carpocapsa pomonella*, L.) has, as usual, been mentioned frequently in correspondence, but, on the whole, owing to the enormous apple crop and also to the more general adoption of spraying, has not done much harm.

"Berwick, King's Co., N.S.—Codling Moth did but little injury. Fruit seldom was so free from worms."—S. C. PARKER.

The only mention of this insect in the Nova Scotia *Crop Report* for November, 1896, is the following:

"Lawrencetown, Annapolis Co.—Very few wormy apples."—J. W. WHITMAN.

In the Ontario *Crop Returns* for August, 1896, there are only two correspondents who mention this insect as follows:—

"Plympton, Lambton Co.—There are no worms in the apples so far this year, even where spraying has not been done."

"Ashfield, Huron Co.—Spraying was little practised and yet the fruit is almost free from fungi and worms. This is unusual, and spraying with proper mixtures should not be disregarded, for this exemption may not occur again."

"Grimsby, Wentworth Co., Ont.—The second brood of Codling Moth has been very troublesome this year in some orchards, particularly where spraying has been neglected. One of my orchards on the hill-side was very difficult to reach with the spraying waggon, and, therefore, it was neglected. As a result, a very large proportion of the apples were affected and had to be thrown out as seconds. Although spraying for fungi has not been so necessary this year, yet spraying for Codling Moth has been as necessary as ever."—L. WOOLVERTON.

"St. Catharines, Lincoln Co., Ont.—The Codling Moth has not been quite so bad as usual, though the enormous crop of apples pointed to by the sceptical as evidence of the futility of spraying is rather misleading. The number of Codling Moths active this year would have made a very different showing if the crop of apples had been a small instead of an abnormally large one."—MARTIN BURRELL.

"Freeman, Halton Co., Ont.—In the younger apple orchards the Codling Moth did a great deal of damage, a large proportion of otherwise very fine apples being injured. The thinner the crop on a tree, the greater was the proportion of wormy apples. Some varieties seem more liable to attack than others. With me the Greening seems always to be the worst infested. The Baldwin, too, suffers a great deal, as well as the Roxbury Russet. The Ribston Pippin, Blenheim, King and Cranberry appear to get off better."—A. W. PEART.

"Craighurst, Simcoe Co., Ont.—Little damage from Codling Moth this year."—G. C. CASTON.

"Hamilton, P.E.I., Sept. 14.—Where spraying is attended to, the Codling Moth is a thing of the past."—H. A. STEWART.

TENT CATERPILLARS (*Clisiocampa*).—These easily destroyed caterpillars have caused much loss in several parts of Canada this year.

"Freeman, Halton Co., Ont.—The Tent Caterpillars have not been troublesome in the Burlington district this year, but some ten or twelve miles north of here they almost amounted to a plague, whole orchards, in some cases, being stripped of their leaves before the owners realized the fact. There was then a general attack made on them, chiefly by crushing their nests in the evenings and mornings. Spraying effectually disposes of them with me."—A. W. PEART.

"Berwick, King's Co., N.S.—The Tent Caterpillar seems to thrive best in the villages. It seldom becomes numerous in isolated orchards. I think the ornamental trees in towns and villages prove a good breeding ground for this insect. The usual formula—4 ounces of Paris green to 40 gallons of water—applied twice will exterminate this enemy."—S. C. PARKER.

"Alberton, P.E.I., Aug. 3.—The Tent Caterpillars seemed to be more numerous than ever. They were the chief leaf-eaters this season."—REV. A. E. BURKE.

"Hamilton, P.E.I.—The most troublesome insect this season has been the Tent Caterpillar."—H. A. STEWART.

"Victoria, B.C.—Tent caterpillars have been very destructive to the foliage of fruit trees in many places, especially Chilliwack, and I notice that the eggs are numerous everywhere in the orchards."—R. M. PALMER.

Effective remedies for Tent Caterpillars are hand-picking of the eggs in winter and the destruction of the colonies of young caterpillars when the young leaves are unfolding, at which time they are conspicuous by reason of the copious white silky web upon which they rest. If not attended to at this time, spraying with Paris green disposes of them easily.

THE EYE-SPOTTED BUD-MOTH (*Tmetocera ocellana*, Schiff.) has been troublesome in certain districts.

"St. Catharines, Lincoln Co., Ont.—I inclose a peach pest which I consider the most dangerous insect I have met with."—A. GLASS.

"Olinda, Essex Co., Ont.—I send you a number of peach twigs injured by a pest which I have not noticed before. This spring a great many trees are badly infested, the young shoots even being attacked, the insect boring down through them."—J. O. DUKE.

"St-Henri de Montréal, Que., June 8.—I notice the bud-moth and leaf-roller have been very bad in some orchards in this neighbourhood. I have kept them subdued by the use of Paris green and the Bordeaux mixture."—R. BRODIE.

"Victoria, B.C.—I have found the Bud-moth is increasing in numbers in our orchards. I hope that the use of Paris green in combination with the Bordeaux mixture will soon become general in lower British Columbia, as the numerous leaf-eating pests are becoming much more destructive."—R. M. PALMER.

This insect is certainly a difficult one to cope with and also, from its habits of attacking the flower buds and boring down into the fruit spurs, its injuries are frequently very serious. The remedy which has given the best results is to spray very early, just when the buds are bursting. The partially grown caterpillars pass the winter snuggly ensconced in silken shelters on the twigs of trees which they infested the previous autumn. About the time the buds open, they leave these shelters and crawl out to the tips of the twigs where they do much harm to the unfolding buds.

CANKER-WORMS have been complained of as usual in many localities, and the importance of early spraying while the caterpillars are very small has been again shown. Two or three correspondents mention that they have been unable to control this insect, even when spraying with a mixture strong enough to burn the foliage. A very serious out-break occurred in Pelham township, Monck County, Ont., and another near Fredericton, N.B.

THE CIGAR CASE-BEARER (*Coleophora Fletcherella*, Fernald) has been mentioned by correspondents in all provinces in Eastern Canada, but no complaints of serious attack have been received. Mr. Harold Jones, of Maitland, Grenville Co., Ont., noticed the young Case-bearers moving from their winter resting places out to the buds on 2nd May last. He sprayed at once with the kerosene emulsion (Riley-Hubbard formula), 1 to 12, with the result of practically clearing his orchard of this insect.

THE OYSTER-SHELL BARK-LOUSE (*Mytilaspis pomorum*, Bouché) continues to trouble the apple grower in many districts. It occurs in every province of the Dominion and spreads rapidly, particularly in neglected orchards.

"Baddeck Forks, Victoria Co., N.S.—The scale insect is the greatest pest. All our apple trees will be killed in a few years more if we cannot stop its ravages."—A. B. WATSON.

"Nappan, Cumberland Co., N.S.—The apple tree bark-lice give me the most trouble I used kerosene emulsion twice in June, but there are still many on the trees. Do you think the application now of a mixture made up as follows would not be advisable: concentrated lye, 3½ lbs.; fish oil, 1 gallon; water, 8 gallons? It seems impossible to get kerosene emulsion to all parts of the tree when in foliage. I do not think they are troubled much with this pest in the Annapolis valley; at least, I never noticed many there. But, all through the country where I have been, trees are being killed or at least stunted by the bark-louse."—W. S. BLAIR.

"Berwick, King's Co., N.S.—As usual the bark-louse gains ground on trees that are not in good cultivation. Alkaline washes which are recommended will clean the trees up completely, and I think that the thorough applications annually will also prevent the work of the shot-borer (*Xyleborus dispar*, Fab.)."—S. C. PARKER.

"Alberton, P.E.I.—If we cannot soon get means to destroy the Oyster-shell Bark-louse, we shall have to give up raising apple trees."—JOHN T. WEEKS.

"Lakeville, P.E.I.—Please send me receipt for wash to destroy bark-lice on apple trees. They are fast destroying our trees."—JOHN J. MCINNIS.

"Freeman, Halton Co., Ont.—The Oyster-shell Bark-louse has had its day in this district. There are but few left, and these only on neglected trees. Ten years ago they threatened to sap the life out of the orchards."—A. W. PEART.

The recognized remedies for the Oyster-shell Bark-louse are spraying the trees, before the buds burst and again in June when the young are moving, with the Riley-Hubbard kerosene emulsion (1 to 9). At the same time a healthy, vigorous growth should be induced by judicious pruning of the trees, manuring the roots and cultivating the soil.

Several instances have been brought to my notice, which would indicate that trees badly infested with the Oyster-shell Bark-lice, after having been sprayed with Bordeaux mixture, were much freer from these insects. This was possibly due to the fact that twigs bearing a coating of Bordeaux mixture were thereby rendered distasteful or unsuitable for the young bark-lice when seeking a spot to settle.

The PEAR-TREE SLUG (*Eriocampa cerasi*, Peck), has been very abundant in Ontario, Quebec and British Columbia. I cannot help thinking that the reason this pest of the pear, plum and cherry is so prevalent every year, is that the late broods are neglected. Spraying with the standard mixture of Paris green (1 pound in 200 gallons of water with 1 pound of fresh lime) is always fatal to the larvæ.

"Grimsby, Ont.—The Pear-tree Slug has been more destructive than usual. It has skeletonized the leaves of the pear, plum and common cherry trees, and, where it has been left unchecked, has done a great deal of damage in stunting the growth of the

trees. The second brood is more troublesome to us than the first, because at that season fruit-growers are so busy that it is almost impossible to find time to spray with Paris green."—L. WOOLVERTON.

"St. Catharines, Lincoln Co., Ont.—The Pear-tree Slug has done more damage than most pests in this district, familiar as it is and easy to fight as it is. I think I am well within the mark in saying that it has been far more destructive than in any season for the past decade. The second brood worked very freely on the plum as well as on the quince, cherry and pear, and thousands of young trees—particularly cherry—had their leaves skeletonized."—MARTIN BURRELL.

The PLUM WEB-WORM (*Lyda rufipes*, Marlatt).—When travelling through the Mennonite country in Southern Manitoba in the first week of July last I noticed a great deal of damage done to plum trees by the gregarious false-caterpillars of a saw-fly which webbed together the leaves of small branches and soon stripped them of all green cellular portions in a very similar manner to the larvæ of the Cherry-tree Tortrix (*Cacœcia cerasivorana*, Fitch). Upon examining the webs I found them to be filled with enormous numbers of a false-caterpillar of a species of saw-fly belonging to the genus *Lyda*, which was quite unknown to me. The larvæ were nearly ¾ of an inch in length, grayish above, yellowish or pinkish below; head yellow, thoracic shield and feet as well as the tip of anal segment, black; pro-legs wanting. They have two seven-jointed antenna-like appendages, protruding from the front of the head, and also two others three-jointed, from each side of the last segment. I was unable to rear the perfect insects, but I find a description of what is evidently the same species by Prof. T. A. Williams in *Bulletin 38*, April, 1896, of the South Dakota Experiment Station, in which the insect is described and figures are given of the perfect insect, the cluster of eggs and a bunch of sand cherry infested by the larvæ. It is described as one of the most destructive insects attacking plums and cherries. It feeds upon all the common forms both wild and cultivated. It is found most often on the common wild plum (*Prunus Americana*, Marsh) and the sand cherry (*Prunus pumila*, L.). Prof. Williams describes the mature insect as much flattened, with body, head, antennæ and feet shining black, legs reddish. He gives as the date of appearance of the flies the second week of June. The larvæ which I found in Manitoba were full-grown in the first week of July, and at that time most of the plum trees in the gardens of the Mennonites over an area of many miles were almost entirely defoliated.

The eggs are deposited in close masses along the under side of the mid-rib of the leaf, the long axis of the eggs lying parallel with the mid-rib. The younger leaves are invariably selected, and the eggs laid before the leaf has expanded. Immediately on hatching, the young larvæ begin to spin a web and feed through or crawl over to the upper surface of the leaf. As they continue to grow, they travel to other leaves and envelop all in a tough web not unlike that of the tent caterpillar. A large colony will spread over the whole side of a tree before the insects become full-grown. When ready to pupate, the larvæ go to the ground and gradually envelop themselves in cocoons, turn to pupæ and emerge again [the next year] in the late spring or early summer as mature insects."—(*South Dakota Experimental Station, Bulletin 48*).

As a remedy, plum trees should be sprayed with Paris green or dusted with white hellebore as soon as the webs appear.

It is just possible that this insect may be the *Lyda fasciata* of Norton, described and figured by Prof. A. S. Packard on page 524 of his *Forest Insects* under "Cherry Insects." But, until specimens are secured of the Manitoba insect, it will be impossible to identify the species with certainty. From the manner of occurrence of the colonies seen in the Mennonite villages, the idea of an imported species is suggested, such as *Lyda pyri*, Schrank, mentioned in Miss Ormerod's last report, as having caused a similar injury in English orchards. Synonyms of the latter are also *L. clypeata*, Klug; *L. fasciata*, Curtis and Westwood, and *Pamphilius flaviventris*, Cameron.

The SAN JOSÉ SCALE (*Aspidiotus perniciosus*, Comstock).—An important discovery has been made by Mr. R. M. Palmer of undoubted specimens of the San José scale in Vancouver Island. From the appearance of infested wood forwarded, the pest must have

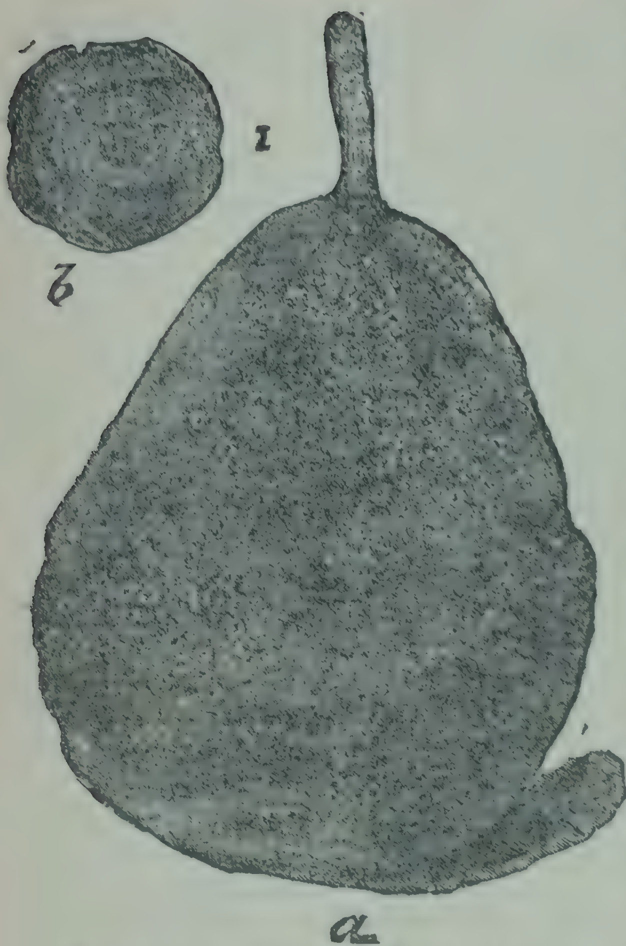

Fig. 14.—Pear attacked by San José Scale; *b*, scale much enlarged.

existed for some years on the trees where it was found. So that there might be no mistake as to the identity of the species, specimens were sent to Dr. Howard, United States Entomologist, who confirmed Mr. Palmer's opinion.* In a most interesting report sent to me by Mr. Palmer on the insect injuries of the year, he writes of the matter as follows:—

"Victoria, B.C., Dec. 10.—I am sorry to report that I have found San José Scale in two orchards on Vancouver Island. The infested trees have been destroyed, and, of course, trees and bushes in their vicinity will be closely looked after the coming season. I may say that the popular opinion that San José Scale will kill the trees in three years, is not borne out by observations made here on these infested trees. One of them, at any rate, had apparently been infested for a much longer period, and it was still growing. I find it difficult to detect the presence of the scales on the trees, or, rather, very close observation is required. In both of the above cases my attention was drawn to them by the characteristic marking of the fruit growing on the trees, caused by the insect."

"Victoria, B.C., Dec. 29.—*Re* San José Scale: I send you part of the infested wood and twigs I have. It is rather dried up now, but when fresh the characteristic marking of the twigs, leaves and fruit, due to the work of the insect, was very evident, and there was no doubt as to the identity. It was the bright discoloration of the fruit which first drew my attention to the presence of the insects in both the cases found. A microscopic examination was also made on my return to Victoria, which confirms this opinion."—R. M. Palmer.

The limits of distribution of the San José Scale, like those of all other insects, are undoubtedly controlled to a large extent by climate. It has been found from long-continued observation that both animals and plants are restricted in their distribution to what have been called "life zones," which are determined, according to Dr. C. H. Merriam, the eminent zoologist, "by the total quantity of heat during the season of growth and reproduction." The San José Scale occurs more or less in all the States lying to the south of the great lakes, and although the data upon which life zones could be laid down accurately in Canada are too meagre to be of use in consideration of the question whether this insect would be likely to spread and become a serious enemy of the fruit grower in Canada, there is no doubt that it must be regarded as a very possible danger, at any rate in those parts of Ontario which lie along the north shore of Lake Erie, extending perhaps from the County of Essex to the County of Wentworth. It was supposed at one time that the San José Scale would not thrive east of the Rocky Mountains, but we now know that this supposition was erroneous; therefore, all fruit growers, particularly in that part of Ontario mentioned above, are urged to be keenly on the alert to watch for and report promptly any occurrence of this or any other scale insect which resembles it, either in their orchards or upon young nursery stock imported from the United States. In cases of doubt, specimens should be forwarded for examination, as soon as detected.

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*Since the above was written two other instances have come to my knowledge of trees in Canada being infested with San José Scale, and samples have been received and examined. One infestation is at Chatham, Ont., the other at Niagara, Ont. Every care is being taken in both places, to eradicate this serious enemy of the fruit grower.—J. F.

Remedy.—A very complete series of experiments was conducted, not only at Washington, but also in many other parts of the Eastern United States, in which every material known as an insecticide for scale insects was tried, and Dr. Howard's final conclusions are now of value to us. He says: "With the San José Scale the most satisfactory work can be done only with a winter wash; for this species may be found in various stages of development at any time through the summer months, and an emulsion spray at any given time will kill only a small proportion. Moreover, the young larva of the San José Scale settles almost at once and immediately begins secreting a dense scale which after 48 hours is practically impervious to the ordinary emulsion diluted so as not to injure the foliage."

As stated above, the only satisfactory treatment for this insect is a winter wash, and the question naturally arises. Which is the best? Dr. Howard answers this for us: "But one absolutely satisfactory winter wash has been found. This is whale-oil soap (not containing more than 20 per cent of water) a pound and a half or two pounds to a gallon of water. This mixture killed every insect upon the trees to which it was applied, as was proved by a very thorough examination. Good whale-oil soap can hardly be bought for less than four cents a pound by the barrel, and this makes a thorough winter treatment an expensive matter. The best recommendation that can be made from the present outlook, however, is to use this mixture soon after the leaves fall in the autumn, and then, if examination reveals any survivors, to repeat it shortly before the buds open in spring."

The San José Scale is one of the most injurious insects which have been found on fruit trees, and, should it be allowed to establish itself in our Canadian orchards, it will be the cause of great loss to our fruit growers. It is, therefore, imperative that all should exercise the utmost care in examining their trees if they have been lately imported, and in buying trees only from nurserymen whose stock is known to be free of infestation. The home-grown trees of all of our Canadian nurseries are certainly much safer in this respect than those of any in the United States.

The San José Scale is a small flat scale insect, only about $\frac{1}{16}$ of an inch in diameter and so hard to detect on the bark of trees that it can hardly be recognized without a magnifying glass. The best indication of its presence is the dirty grayish appearance of the bark as if ashes had been dusted over the trees.

The Plum Curculio (*Conotrachelus nenuphar*, Hbst.).—Many reports from all parts of Eastern Canada referred to the Plum Curculio as abundant, but the injury was not appreciable this year, owing to the enormous crop. Mr. L. Wolverton says: "The Plum Curculio has not been quite as troublesome this season, perhaps because of the abundant crop in this section, which made its attacks less noticeable." Mr. S. C. Parker, of Berwick, N.S., also says: "The Plum Curculios were plentiful, but could not destroy enough to lessen materially the enormous crop of plums. Some of our plum growers pick up carefully all the dropped plums, and claim that they can thereby keep their plum orchards free from the Curculio."

The Grape Phylloxera (*Phylloxera vastatrix*, Planch.).—This insect, so well known by name from its enormous injuries to the vineyards in Europe, is seldom the cause of serious injury in Canada. It, however, attracted much attention in the Grimsby district last summer. Mr. Wolverton reported it as "unusually abundant on the leaves of grape vines throughout this district. In many cases hundreds of vines on one plantation had their foliage covered with the galls of this louse. I examined some sections of these galls under the microscope and could see great numbers of the eggs and several fully developed insects. I have not recommended any special remedy, because I note what you say that the Phylloxera is not to be looked upon as an important enemy in our Canadian vineyards, as, although a native, it has not in the past caused serious loss. I have never observed any of the variety which affects the roots, nor have I had any one report it to me."

The Peach-bark Borer (*Phlœotribus liminaris*, Harris).—I have referred in previous reports to the extensive injuries due to this minute insect in the peach orchards of the Niagara district, and also to some successful experiments carried out by Mr. Carl E. Fisher, of Queenston, Ont., with an alkaline wash, to which Paris green, lime and

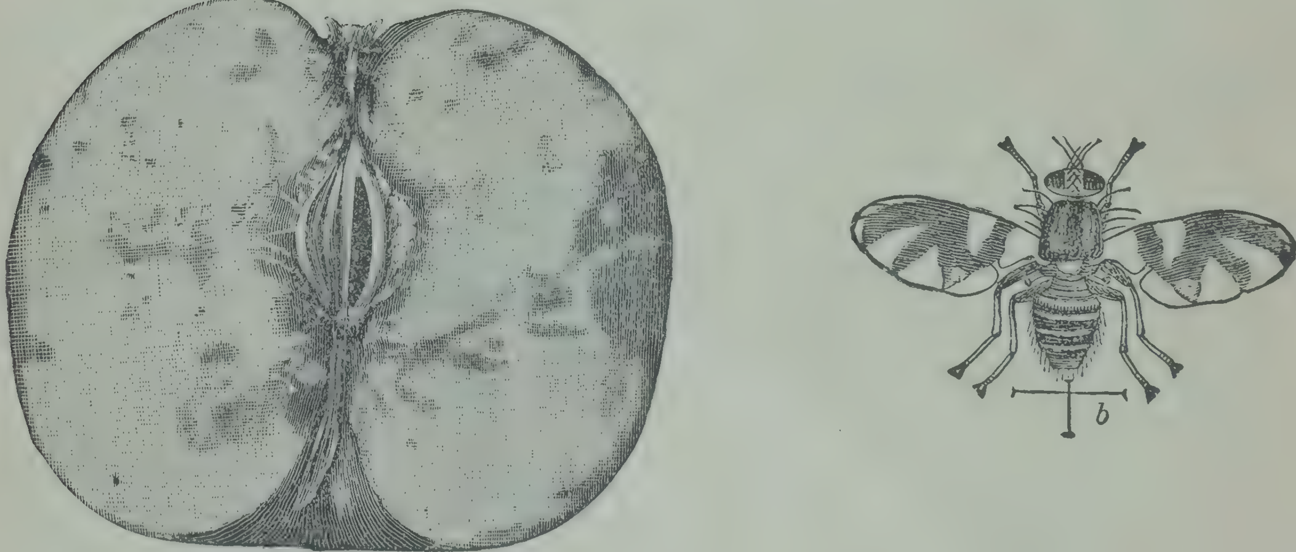
carbolic acid were added. This wash has been again used successfully during the past season by Mr. Fisher, who writes: "The last wash I used for the Peach Bark beetle was the dead shot remedy. Every tree it was tried on is free from the little beetles." This remedy is applicable for many other bark-boring beetles, such as the Shot-borer of the apple and plum. The formula, as last used by Mr. Fisher, is as follows:—

Washing soda, 5 pounds; soft soap, 3 quarts (or hard soap, 3 pounds); water to make 6 gallons; air-slaked lime sufficient to give the mixture the consistency of thick paint; finally, add 4 ounces of Paris green and 1 ounce of carbolic acid. To be applied with a whitewash brush, thoroughly covering the trunk of the tree and a few inches up the limbs. The first application should be made as soon as the beetles appear in the spring, sometimes as early as the middle of March. Two or perhaps three applications, a month apart, may be necessary.

The Black Peach Aphis (*Aphis persicæ-niger*, E. F. Smith).—Letters from Essex County and a single one from St. Catharines show that a good deal of injury is being caused in young peach orchards by the Black Peach Aphis. Up to the present no satisfactory remedy has been applied, but experiments have been arranged to be carried out next season. The application of kainit, as advised by Prof. J. B. Smith and mentioned in my last report, is specially commended to the attention of peach growers. Prof. Smith says: "In our State, on light soil I advise about 10 pounds of kainit per tree, covering the probable extent of the root system—this for a tree 4 to 6 inches in diameter and in bearing—the application to be made in spring, when the trees are leafing out. In our orchards the kainit has proved successful wherever used. Dr. Erwin F. Smith recommends ground tobacco, and so does Prof. Alwood, of Virginia."

THE APPLE MAGGOT.

(*Trypeta pomonella*, Walsh.)



Infested Apple. Perfect fly.

Fig. 15.—Apple Maggot.

Attack.—Slender, white or greenish white footless maggots; when full-grown, about $\frac{1}{4}$ of an inch in length by $\frac{1}{12}$ of an inch in width, tapering gradually to the head and cut off abruptly behind; burrowing in all directions through the flesh of apples, feeding upon the pulp and leaving brown channels. There are sometimes as many as a dozen maggots in a single apple, but one is enough to render it worthless. The eggs are inserted beneath the skin of the fruit by a two-winged fly with a sharp ovipositor. The young maggots which hatch from these become full-grown in about six weeks, causing the fruit to ripen prematurely and drop to the ground, when the maggots work their way out and entering the soil a short distance, change to pale coloured puparia, inside which the maggots remain unchanged until the following spring. The pupa state is assumed only a few days before the perfect insects appear.

The fly of the Apple Maggot (Fig. 15, *b*) is a pretty little insect described as follows by Prof. Harvey, of Maine, who published a most complete study of this pest in the "*Annual Report of the Maine State College* for 1889": "The perfect insect is a two-winged fly somewhat smaller than the house-fly, readily recognized by its general black colour; yellowish head and legs; dark feet; greenish prominent eyes; white spot on the back and upper part of the thorax; three white bands across the abdomen of the male and four across the abdomen of the female, and four black bands across the wings, resembling the outline of a turkey."

The injury done to the apple crop by the Apple Maggot in the states of New York, Massachusetts, Connecticut and Vermont are well known, but, outside of these States, although the insect is common and feeds in the larval form upon the fruit of the hawthorn (*Cratægus*) over a large area of country, there is no record of its having attacked cultivated apples to any appreciable extent. During the past summer, however, infested apples were received from Dr. D. Young, of Adolphustown, Lennox Co., Ont., north of Lake Ontario, with the following letter, which is the first record of its injurious occurrence in Canada:—

"Adolphustown, 31st October.—I send you apples injured by worms of some kind from a tree that heretofore always produced very clean and smooth fruit. Kindly tell me what the worm is and what remedy to apply. I spread round the trees which bore the infested fruit ten or twelve wagon loads of barn-yard manure in the spring of 1895 and again in 1896. I fear this may have enticed the insect. What gives me this idea is that I have two trees, a Golden Russet and a Winesap, that always produced clean fruit till we put a pig pen and yard right between them, the roots running under the pen and yard where the soil is immensely rich. Since the pigs were kept there, the fruit on these two trees has been very poor, and this year was entirely worthless on the Golden Russet. Although heavily loaded, there was not on the tree one good apple, and the Winesap was nearly as bad. It was heavily loaded too, but I think not one in fifty was good for anything. Yet the apples on the other Golden Russet and Winesap trees near by were very fine."—Dr. D. YOUNG.

A little later Dr. Young sent me a good supply of infested apples, with the statement that the maggots were working in other varieties than those mentioned. No living maggots were found in these, but two dead specimens served to identify the species in confirmation of the opinion formed from the very characteristic work of the larvæ in the fruit.

There is only one brood of this insect, but the eggs are laid by the females during a very long period, namely, from the beginning of July till frost sets in. The flies, which are produced from early ripening varieties of apples, appearing at a correspondingly early season the following year, and those from late varieties lay the eggs which produce the maggots found in the stored apples during the winter. Prof. Harvey says: "We have never seen the exit holes in hanging fruit, and believe the maggots do not drop, but go into the ground from the fallen fruit. Their presence causes the fruit to mature earlier. Fruit picked from the tree may contain larvæ, and often stored or marketed fruit is alive with maggots. Apples apparently sound when gathered may, by the presence of eggs or young larvæ, afterwards become hopelessly involved. The development of the maggot is slower in late and hard fruits."

When infested fruit is stored, the maggots emerge as they become full-grown and turn to puparia inside the barrels or bins.

Remedies.—As the egg of this insect is laid beneath the skin of the apple, it is evident that spraying with poisonous applications would be useless. The remedy which is most relied on by those who have had experience with the insect, is the prompt destruction of windfalls, so as to prevent the maggots going into the ground. This can be done by keeping a sufficient number of pigs, sheep or other stock in the orchard. If this is inconvenient, the more expensive operation of collecting by hand and destroying or feeding to stock must be rigorously practised if this pest is to be controlled. The refuse from bins or barrels should, of course, also be dealt with in some way to prevent the insects coming to maturity. Prof. Harvey says emphatically: "The gathering of windfalls for the express purpose of checking *Trypeta* has been tried and found effectual. We firmly believe we have in the careful destruction of the windfalls, the means of

destroying the pest. If windfalls are left lying in an orchard, the maggots will leave them and enter the ground: but they always remain near the surface, so that deep spading or ploughing would bury most of them so deeply that the flies would be unable to emerge. A most useful practice also is the penning up of poultry beneath infested trees; these will scratch out and devour large numbers of the insects."

It is hardly likely that the flies were attracted by the odour of the manure applied by Dr. Young to some of his trees or by the pig-pen beneath others, but the observation is well worthy of being remembered in case the Apple Maggot spreads and becomes more destructive in Canada. A characteristic of the occurrence of this insect is its slowness in spreading from one locality to another, from orchard to orchard, or even from variety to variety and from tree to tree in an orchard. It is said to be largely confined to sheltered locations and sandy soils.

THE APPLE FRUIT-MINER.

Fig. 16.—Apples injured by Apple Fruit-miner.

Attack.—Small caterpillars tunnelling in all directions through the flesh of apples, discolouring them and rendering the fruit unfit for use; when full-grown, they are a little over a quarter of an inch in length, dirty white in colour, tinged with pink just before spinning their cocoons. Head and a small shield at the end of the body, dark brown, somewhat resembling the caterpillar of the Codling Moth, but only about half its size when full-grown, and with the body much more tapering to each end. When ready to spin up, these caterpillars leave the fruit and make cocoons which in nature are probably placed in crevices of the bark in the same way as those of the Codling Moth.

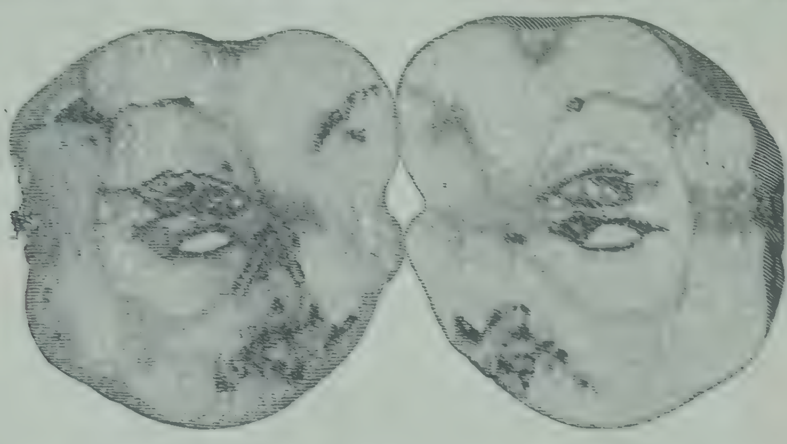


Fig. 17.—Apple injured by Apple Fruit-miner (inside).

Nothing is known of the egg-laying habits of the moth from which the caterpillars spring, but, from the appearance of the infested fruit at the entrance of the tunnels, it would appear possible that the young caterpillar may live at first for a short time on the foliage or beneath a leaf attached by it to the fruit. A point of entry is frequently marked by several very small tunnels opening over the surface of a comparatively large area one-eighth of an inch to one-quarter of an inch in diameter, as if the insect had fed

there for some time. With the growth of the fruit, this point becomes the centre of one of several—sometimes 3 or 4 on a single apple—conspicuous depressions, by which the apples are much distorted; the blackened skin at the botton of these depressions is also frequently further discoloured by a white deposit, probably consisting of dried-up juice from the apple, which has oozed from the wound.

This is a most serious enemy of the apple grower on the Pacific coast, and it is to be hoped that every effort will be made next June to discover the method of egg-laying and the early habits of the young caterpillar. As the injury is done chiefly inside the fruit where the insect cannot be reached, it is probable that any practical active remedy will require to be applied at or soon after the time the eggs are laid.

It is strange that this insect, which injures the fruit of the apple in such a very similar way to that of the Apple Maggot (*Trypeta pomonella*, Walsh), should have broken out in British Columbia just at the same time as the latter insect was discovered in Ontario as a pest of cultivated apples.

It is probable that both of these insects are native species which are abundant in their wild food plants, the Apple Maggot in the fruit of hawthorn, and the Apple Fruit-miner in the wild crab (*Pirus rivularis*, Dougl.), and that the habit of attacking cultivated apples is exceptional with both; but, as *Trypeta* has shown that when once this bad habit is acquired it is very persistent although local, no effort should be spared to to find out as soon as possible with regard to this new enemy, all that can be known of its life habits, so as to arrive at a remedy.

As far as reports have been received, the injuries of this insect have not been noticed in the interior of British Columbia. Mr. Thomas G. Earl, the owner of a beautiful orchard at Lytton, on the Fraser River, just within the limits of the arid climate which characterizes the Interior Plateau of the province, says:—"I am happy to say I am not troubled with the worm you mention. I have seen it at Chilliwack and Agassiz."

The following interesting letters will show the serious nature of this new pest, and also give all that is actually known of the life history:—

"Victoria, B.C., July 17.—I send two specimens of infested apples forwarded to me from Chilliwack. Can you let me know what has caused the injury?"—R. M. PALMER.

"Victoria, B.C., Aug. 20.—Mr. Gibson has been looking after a number of specimens of the apple caterpillars from Chilliwack, and has succeeded in getting some cocoons. I hardly think the moths will emerge till spring."—R. M. PALMER.

"Agassiz, B.C., Aug. 12.—I send you, under another cover, some apples infested with a worm. This appears to be very prevalent in some districts in British Columbia this year. I noticed a few cases in previous years, but these were so few that I did not trouble about them, but this year it is a pest."—THOS. A. SHARPE.

"Spence's Bridge, B.C., Sept. 15.—I collected another box of apples infested with that new pest and have mailed them to you from Agassiz. I spent last Friday in Victoria, most of the time in the Department of Agriculture and with Mr. Anderson at his house. Mr. Anderson's assistant showed me several of the cocoons of this new pest in the apple, which seems to me to be much more injurious than the Codling Moth. It is a lepidopterous insect which, judging from the larva and cocoons I have seen, is about half the size of the Codling Worm. The cocoons are closely spun inside, with an outer covering of whitish silk of a neat and open pattern. The larva, as you will see, eats channels all through the flesh of the fruit, completely spoiling the apple for use. At the Department of Agriculture here the cocoons had been obtained by putting the apples uncut into a large glass jar and tying it over with gauze. As the larvæ matures, it finds its way out and spins its cocoons at the sides of the bottom of the jar."—DR. WM. SAUNDERS.

"Agassiz, B.C.—I sprayed when the blossoms had fallen and once when the fruit was as large as a small crab. I dealt effectually with the caterpillar, and if Paris green were a remedy for this pest, I should have expected it to be killed at the same time, but it was not, or at least there were a great many left. I gathered a number of apples that I knew were infested and put them in a glass jar, covering it with thin muslin. I also mounted specimens, but have found out nothing definite. Of some varieties of apples, such as St. Lawrence, Wellington, American Pippin, Stark, Maiden's Blush and Fall Pippin, more than half the crop was injured. Other varieties suffered less, though to a considerable extent; and some varieties, like Winter St. Lawrence, Salome, Mann,

Yellow Bellflower, Scott's Winter and Sutton Beauty, were practically uninjured. I hear from some purchasers that many apples sold are injured by the maggot, which goes to show that in some cases at least they are taking no care for next year, as in late picked specimens I found very few worms, but evidence of their having been in the fruit."—THOS. A. SHARPE.

"Victoria, B.C., Dec. 10.—Your valued favour of the 30th ult. to hand and contents noted. In reply *re* Apple Fruit-miner, Mr. E. A. C. Gibson has been making a special study of this pest, and any information or specimens which I have obtained have been turned over to him. As I know he intends sending you a full account of his work, I do not wish to anticipate him, so will only say that the insect has been specially destructive in the Chilliwack valley, and in the Mission City and Agassiz districts, but to a lesser extent is widely distributed in the lower part of the province, as I have received or observed specimens and their injuries at Ladner's Landing, Victoria, Cowichan and the Islands, as well as the lower Fraser valley. I am of opinion that it is a native insect. Its proper food is the fruit of the native crab apple. This Mr. Gibson's observations will determine."—R. M. PALMER.

"Victoria, B.C.,Dec. 11.—I remember having seen these insects in the native crabs for a long time, but apparently they did not attack cultivated apples until recently, or if they did it was not noticeable. At Chilliwack, however, last summer I saw the effects of their ravages on the orchards of that place."—J. R. ANDERSON.

"Victoria, B.C., Dec. 16.—This insect has certainly occurred and been noted before this year, but I do not think it has till now caused any material damage. I secured most of my infested fruit from Mr. Kipp, of Chilliwack, who says: 'It is general throughout the upper end of my district,* and I noticed it at Agassiz as well on August 8th.' Mr. Kipp also says, in answer to some questions I addressed to him: 'I noticed it first about June 20th, found the worm, which was very small at that time, with blackish head, the other extremity the same, the body the same colour as the flesh of the apple (Gravenstein). Later in August the worm was about one-eight of an inch long; body, brown. I found worms from time to time through September. In October I could find no more worms, but late in October or about the first of November hundreds of small moths (white) were flying about mostly all day. Gravenstein, Ben Davis, Russets, Baldwin (slightly), Lady's Sweet, and various other varieties I cannot name, were attacked. * * * Seventy-five per cent of my fruit was affected.' I myself have received specimens of fruit attacked by this insect from Hornby Island as well as Chilliwack. I am sending you by the present opportunity under separate cover specimens of wild crab apples which have been altogether spoilt, as I think, by this same insect, and a piece of an apple, inside which I found the cocoon, which you say you would like to have. I found cocoons in several others as well."—E. A. CAREW-GIBSON.

Mr. Carew-Gibson has also kindly prepared the following interesting note on the subject:—

"NOTE ON A NEW APPLE FRUIT PEST IN BRITISH COLUMBIA.

"The new apple pest which has this summer more strongly forced itself upon our notice than previously, owing to the loss it has occasioned to the fruit crop in some parts of this province, is, I believe, an indigenous insect, as I have traced it back to what I believe is its original home, *i.e.*, the wild crab apple swamps. In the larval stage this insect is very small, when full-grown only measuring a quarter of an inch in length. The larvæ are of a dullish white colour tinged with brownish green, excepting the head, a broken line on the top of the first segment, thoracic feet and last segment with hind pro-legs, all brown. These larvæ diminish in size towards their extremities and can in this way be easily distinguished from the larvæ of the Codling Moth, which, besides, are very much larger when full-grown. A nearly full-grown larva on being caged on the flesh of a freshly cut apple soon disappeared from view; it started by chewing the apple pulp till it had a large mouthful, when it drew back its head from the hole thus made and disgorged the pulp, thereby giving the body room to get farther into the apple, this

* A rich district on the Fraser River extending from Sumas Lake to Popcum, a distance of about 20 miles, with the town of Chilliwack on the Fraser River situated almost centrally.

operation was repeated continuously and the insect was buried out of sight when looked for eighteen hours later. The larvæ apparently enter the fruit from the side, and eat their way into the interior by tunnelling the fruit in all directions. They sometimes reach the core and feed on the apple pips, but more often keep to the more fleshy part of the fruit, which is thus entirely spoilt, as the passages made by these insects soon turn brown and start decay throughout the fruit. When fully grown the larva emerges at the side of the fruit, and probably lowers itself to the ground before spinning up. I judge this to be the case, as by holding the spinning thread of a fully grown larva which had just emerged from the fruit I induced it to lower itself by its thread over six feet. It then spins a very beautiful white cocoon of an open-work pattern, and inside and separate from this, it spins another close-fitting white covering. These cocoons measure about three-eighths of an inch long. I have found cocoons of this insect spun up inside the core of several apples. It will be easily seen, however, that this is only possible in the more open cored varieties of fruit, and the chances of survival are very slight for those following this plan. I have specimens of this insect which spun up as early as August 6th, and also had samples of fruit containing larvæ apparently not full-grown on November 9th. The only sign that the fruit is infested at an early stage of its attack is by the exudation of juice from the fruit at the point where the insect entered, which generally dries up in the form of a little bubble; later, when the larva has left, the small hole in the side of the fruit through which it escapes can be readily seen on a close examination. The rotting of the fruit along the passages made by this insect may be caused by spores of fungi lodging where the apple skin is pierced, and thereby decay working its way along the open passages. My reason for thinking that this insect is indigenous is because I have several cocoons from infested fruit of wild crab apple trees. I have often in previous years noticed that a great deal of the fruit of the wild crab apples is completely spoilt, and have arrived at the conclusion that it is our new enemy which is responsible for the damage. I took some infested wild crab apple fruit and placed it in a jar on September 13th, and on September 25th I had three nicely spun cocoons in the bottom of the jar. The wild crab apple fruit which is affected, when ripe, turns quite black, instead of being of the ordinary brown colour, and one sometimes sees a whole tree with scarcely a sound berry on it."—E. A. CAREW-GIBSON.

The fruit of *Pirus rivularis* is borne in bunches of about a dozen together on slender stalks over an inch in length; each individual fruit is a small, berry-like, ovate, oblong pome, about half an inch in length by three-eighths in width.

Besides the above insects, there are some other caterpillars which injure apples, the life histories of which require working out, owing to the possibility of their becoming of economic importance. At Victoria in 1895 I found specimens of a small caterpillar feeding on the surface of the fruit, particularly at the calyx end eating the skin and mining a short distance beneath it; very similar larvæ were also received during the past summer from Mr. C. P. Newman, of Lachine Locks, Que., but some of these worked entirely beneath the skin, making large blotch mines, but not running nearly so deeply into the flesh as the British Columbian Apple Fruit-miner.

Mr. Palmer says as follows on the subject of the insect enemies of fruit in British Columbia: "The Codling Moth has been reported from several places, but after careful examination of infested or damaged specimens of fruit, I have failed up to the present to find the true Codling Moth. Still considerable damage was caused by worms in apples (distinct from the Apple Fruit-miner) of two or more different species and I hope with Mr. Gibson's aid and your special knowledge that we shall be able next season to determine what the pests actually are (as by that time we ought to have specimens of the perfect insects) and the proper methods of dealing with them."—R. M. PALMER.

As up to the present, owing to the energy of the provincial Department of Agriculture of British Columbia, the Codling Moth has been prevented from being introduced, as far as can be learnt, into that province, and, as larvæ of the Apple Fruit-miner have been mistaken for those of the Codling Moth and its work for that of the Apple Maggot, it may be well to point out some of the important characters in which these three insects differ. There should be no trouble in distinguishing them in all their stages

The Apple Fruit-miner and the Apple Maggot injure apples in a very similar manner, tunnelling the pulp of the fruit in every direction, leaving brown coloured channels with here and there rather large chambers. The injury of the former is generally rather less extensive than that of the latter.

The two insects, however, are quite different in appearance: the Apple Maggot is as its name implies a footless maggot which changes beneath the surface of the ground to a smooth whitish puparium, inside which it remains unchanged until the following spring; while on the other hand, the Apple Fruit-miner is a caterpillar with a distinct head, three pairs of thoracic feet on the segments next to the head, four pairs of short fleshy pro-legs under the middle segments and a similar pair of pro-legs at the end of the body. This turns to a chrysalis in autumn inside a close white cocoon which further is surrounded by an outer web or loose net work of white silk.

The Codling Moth, again, differs as to its work from both of the above. Instead of tunnelling in all directions through the flesh and destroying the whole apple, the caterpillar always works to the core and feeds upon the seeds, in most cases entering the fruit from the calyx end, and emerges through a hole straight from the core to one side. The larvæ of the Apple Fruit-miner and of the Codling Moth are both caterpillars, but that of the Codling Moth when full-grown is nearly three times the size of the Apple Fruit-miner, and is spotted with black, bristle-bearing points. The cocoons, too, are very unlike; while that of the Apple Fruit-miner is one-quarter of an inch long and surrounded by a white, lace-like outer netting, that of the Codling Moth is half an inch long and brown and close, with many particles of the bark upon which it is spun worked into it.

Specimens of the Apple Fruit-miner confined in a jar upon moist earth and with pieces of bark, invariably chose the latter to spin upon, the cocoons being generally placed deep in a crevice or under a flake of bark.

Remedy.—Until more is known of the habits of this insect, it would not be wise to make more than general suggestions as to a remedy. Mr. Sharpe mentions that he sprayed his trees for caterpillars, and that the fruit was badly infested on trees so treated, but no comparison is drawn with trees that were not sprayed. From so much of the life history as is known, spraying with Paris green, lime and water, in the same manner as for the Codling Moth, soon after the flowers fall, with two or three applications a week apart later, would seem to be the most reasonable method, and certainly would, at any rate, have the great advantage of destroying several other kinds of biting insects.

Description of caterpillar of the Apple Fruit-miner from Chilliwack, B.C., made August 3, 1896, after it had emerged from apple:—

Nearly cylindrical, slender, almost three-eighths of an inch long when extended, by $\frac{1}{16}$ in diameter. Head small, fuscous. Thoracic shield fuscous, with a white stripe in centre. Anal plate conspicuous, and on the anterior half of segment 13 is a long, narrow chitinous blotch, similar to the anal shield and probably representing the expanded bases of tubercles. Body whitish, washed all over with pink; bristles white and slender; spiracles inconspicuous; surface of the body uneven; intrasegmental folds deep, as also a median transversal fold on each segment. There is a row of deep depressions above and below the stigmatal fold.

When received on July 24, 1896, the above larva was white in general colour, with black head and thoracic feet. Two larvæ spun on 4th and 5th of August.

A cocoon crushed by accident on October 31 showed that the pupal stage had been assumed. The cocoon is double, consisting of a close, dense, white, spindle shaped inside cocoon, one-quarter of an inch in length, inclosed in a loose bag of open network of large meshes; this is three-eighths of an inch by one-eighth. The inside cocoon is apparently open at one end, for, although no opening can be seen, in nearly every instance the larval skin and head are pushed out into the outer cocoon.

THE HORN-FLY.

(*Hæmatobia serrata*, Rob.-Desv.)

The invasion of Canada by this pernicious insect was first noticed in 1892, and every year since that date losses from the irritating bites of the Horn-fly have been complained of by cattle owners in some new parts of the country. The hope expressed in my annual report for 1893 that the numbers of the flies would after two or three years become less and less in any invaded district, has, to a large measure, been realized. In the province of Ontario, where the first Canadian specimens of the Horn-fly were noticed, there is a decided diminution of the numbers of this pest. Among answers to the questions sent out by Prof. Panton of Guelph, to farmers in different parts of the province, 25 reports were received of its increase and 46 of its decrease, and 25 correspondents noticed no change in the numbers. The following extracts are also of interest:—

"London, Ont., Dec. 7.—The Horn-fly was very conspicuous in its season, but the alarm concerning it seems to have abated."—J. Dearness.

"Sackville, Westmoreland Co., N.B., July 13.—I mail to your address under separate cover several specimens of a very troublesome fly known here as the Horn-fly. They gather in large clusters about the base of the horns and around the root of the tail, also under the flanks. They are evidently the cause of a very decided decrease in the flow of milk among the cows of this place. If you have a remedy for them, please let me know as soon as possible."—John L. Fawcett.

"Pointe de Bute, Westmoreland Co., N.B.—The Horn-fly was not quite so troublesome to the cattle this year in New Brunswick as last, but for several weeks was very active. Very little was done to protect the cows. The impression is growing that the fly will disappear in a short time."—Howard Trueman.

"Yarmouth, N.S.—The prescription I used for the Horn-fly was taken from the *Country Gentleman*:—'Take equal parts of lard and coal oil with a few drops of carbolic acid, and apply every few days as needed.' Any soft grease may be used instead of lard. I observed drinking at a public fountain near my place two yokes of oxen, the bodies of one yoke covered with thousands of these flies, while the others were entirely free from them. 'What do you use for the Horn-fly?' I asked from the driver of the former yoke. 'Fish oil,' was the reply. Whale oil soap would, no doubt, be effective. Along the sea coast fish oil is cheap and easily procured, and it is probably more durable than coal oil and grease."—Charles E. Brown.

"Berwick, King's Co., N.S.—The Horn-fly was very abundant. I found an English sheep dip (E. Liddle & Co.'s., I think,) applied to the cows with a brush about once in three days the cheapest and best preventive I have yet tried."—S. C. Parker.

"Sydney Mines, Cape Breton Co., N.S.—The Horn-fly was not nearly so numerous nor blood-thirsty as last year, and I hope will disappear in a year or two."—David G. Crawford.

"Glace Bay, Cape Breton, N.S.—The Horn-fly continues to give us some trouble, but not quite as much as at first. Various methods are adopted to defeat them, all fairly successful."—Jas. W. Edwards.

"Charlottetown, P.E.I.—The Horn-fly did a great deal of damage here during the summer of 1895. I think a reasonable estimate for milch cows would be about one-sixth shrinkage in the milk flow, and fattening cattle did not do well. Last season (1896) they were not nearly so bad. I hope they have had their day and will not show up in the spring."—Thos. J. Dillon.

"Alberton, P.E.I.—The Horn-fly was, many say, as bad as last year. My own personal observation points to a decrease, but others say to the contrary. Our farmers are at a loss for a cheap effective remedy. Kerosene emulsion, fish oil, vegetable oils are all ineffectual to completely keep off the pest."—Rev. A. E. Burke.

Remedies.—There is nothing new to record in the way of remedies. As previously stated (*Experimental Farm Report*, 1893, page 186), almost any greasy substance rubbed on the animals will keep the flies away for several days. A number of experiments were tried in the field with the result that train oil alone and train oil or lard

with a little sulphur, oil of tar or carbolic acid added, will keep the flies away for from three to six days, while with a small proportion of carbolic acid it will have a healing effect upon any sores which may have formed. Train oil or fish oil seem to be more lasting in their effects than any others experimented with.

The safest and most convenient way of using carbolic acid is in the shape of carbolized oil, which can be prepared by dissolving one ounce of crystallized or liquefied carbolic acid in 1 quart of oil. Train oil, fish oil, tanner's oil, olive oil or any other fixed oil will answer ; but not coal oil, as carbolic acid is not soluble in this liquid. The crude carbolic acid does not dissolve easily in fixed oils, and, therefore, must not be used. Instances have been reported to me of injury to animals and the hands of operators, when the crude has been substituted for the purer form of carbolic acid.

Mr. Robert Elliott, the herdsman at the Central Experimental Farm, finds that the most convenient mixture which is effectual is 10 pounds of lard mixed with one pound of pine tar.

THE APIARY.

The practical management of the Apiary during the past season, as heretofore, has been satisfactorily carried on by Mr. John Fixter, the farm foreman. Mr. Fixter has been of great service in showing visitors over the bee-yard and explaining all matters connected with bee-keeping when consulted. All details with regard to this branch are given in Mr. Fixter's report appended hereto. Mr. Shutt has also kindly prepared a report in continuation of that of last year upon further experiments with different brands of "foundation," which I feel sure will be read with much interest by all bee-keepers.

In May last four colonies of thoroughbred Italian bees were purchased from Mr. M. B. Holmes, of Athens, Ont. Two of these were sent to the Experimental Farm at Brandon, Man., and one each to the farms for the North-west Territories and British Columbia. These bees were very beautifully marked, and the queens were all young imported stock, with the exception of one of those sent to Brandon, which was two years old, but also imported. The colonies all arrived at their destinations in good order, and will be found mentioned in the reports of the various branch farms.

I was much pleased to be able to arrange for a joint mid-summer meeting of the Bee-keepers' Associations of the counties of Russell, Prescott and Glengary. This meeting was held at the Central Experimental Farm on the 12th of June last, and was attended by many of the leading members of the various associations, who expressed themselves as much pleased with what we were able to show them of the work being done in the Apiary.

REPORT OF MR. JOHN FIXTER.

Experiments in Wintering (1895-96).

The experiments begun last year as explained in the report for 1895 were repeated this season and some others were undertaken. Following is a report on these :—

Experiment No. 1.—Seventeen colonies put into winter quarters in the cellar on the 20th of November, 1895. Empty hives were placed on the floor, with 3-inch blocks of wood on the top of them, at the back, and the hives piled up three tiers in height. In addition to the 3-inch blocks, by which the back was raised higher than the front, so as to give free ventilation, each hive was raised from its own bottom board with small blocks ⅜ inch in height. All front entrances left wide open. The wooden covers of all these hives were removed and replaced by chaff cushions, four inches thick. Above the cushions strips of wood, one along each side, prevented them touching the bottom of the hive immediately above them, and also allowed air to circulate freely under each hive.

This mode of wintering was, on the whole, very successful. One swarm, however, died from an unknown cause. When put into the cellar it had plenty of honey and weighed 58 pounds. In spring its weight was found to be $47\frac{3}{4}$ pounds.

The average weight of the 16 other colonies was before winter $50\frac{1}{4}$ pounds., and in the spring $40\frac{1}{4}$ pounds, each colony having consumed an average of only 10 lbs. of their stores against 12 pounds 9 ounces the preceding winter, and 20 lbs. in 1894-95. During the winter scarcely any humming could be heard in the hives, and there was no sign of dampness nor of dysentery.

The product from the 16 hives during the season was, on an average, 47 sections of honey from each, besides 17 pounds. in "extracting-frames" reserved for winter and spring feeding. The 16 hives gave 5 new swarms.

Experiment No. 2.—Two colonies put into the cellar, with tops and bottoms of the hives left on, just as they were brought in out of the bee-yard. These were to be watched for dampness.

By the 30th December, some mould was noticed at the entrance of one hive, and a fortnight later both were very damp, one even had water on the bottom board. In this hive, however, the bees kept very quiet and scarcely any hum could be heard, while those of the other hive were very restless, some coming out at the entrance from 30th January; consequently, on 10th February, a little ventilation was provided by displacing somewhat the wooden cover; nevertheless, on 1st March, there were signs of dysentery, and about half a pint of dead bees was removed. By 16th March signs of dysentery appeared also on the other hive, and on the 1st April both seemed to be in a very bad condition, a considerable number of dead bees having to be removed from them.

On 15th April the two hives were taken out and placed on their summer stands; there were many dead bees and mould on the bottom board; but the colonies were still fairly strong. The bottom boards were removed and clean ones put in place of them.

On 27th April the hive that had been the quieter one during winter, was found deserted; its frames were very mouldy and soiled with fæces. The other hive, on the same date, had two frames partly filled with brood and with new honey. The product of this hive and of one swarm which it gave, was 92 sections of honey.

Experiment No. 3.—One colony was placed in a packing case in the cellar, on the 22nd November, 1895, and packed with four inches of dry sawdust all round the hive; brood chamber raised from bottom board by four small 1-inch blocks; wooden cover of hive replaced by a 4-inch chaff cushion, and the packing case filled up with four inches of dry saw-dust above the cushion. For ventilation a small shaft of the same size as the opening to the Langstroth hive, led from the opening of the hive to the outside of the packing case. Case placed on the top of another case, three feet high, in the stone cellar beneath dwelling house.

About the 21st of January, this colony began to be uneasy; some bees were coming out. On 30th January, the top was somewhat displaced to give ventilation; nevertheless bees kept coming out, though the cellar was perfectly dark, and on 14th February a piece of thin netting was placed over the entrance to stop them. On 1st March, there were many bees dead about the entrance which was much soiled with fæces. The number of dead bees then became less and less, and on 1st April the colony was perfectly quiet. On 15th April it was taken out of the cellar and found to be in a very weak condition with no more than one frame of bees; the other frames were much soiled with fæces. The weight of the hive, 55 pounds on 22nd November, was now reduced to 39 pounds, the bees having consequently consumed 16 pounds of honey.

On 1st May the bees though weak were gathering pollen actively; on 15th May the hive contained two frames with brood and much new honey, but no eggs and no queen. One queen cell only was capped. On 25th May, all the brood had emerged and flown away leaving scarcely a dozen bees in the hive. On 30th May, the hive was deserted, the queen cell not being uncapped; 7 pounds of fresh honey had been gathered into the brood chamber.

I am of the opinion that this colony perished from being kept too warm and for want of sufficient ventilation.

Experiment No. 4.—This experiment is very similar to the last, but no ventilation was provided, it having been claimed by one of our correspondents that he had always wintered bees satisfactorily in this way.

The bottom board of the hive was removed and the hive was stood on four blocks $1\frac{1}{2}$ inches high, one under each corner, placed right on the bottom of the packing case, which was then filled in with dry saw-dust, four inches all round and above, as in Experiment 3, except that no shaft for ventilation was cut through to the outside of the packing case; but immediately beneath the hive there was a narrow crack between the boards of the packing case, not $\frac{1}{16}$ of an inch wide. The packing case itself was raised about an inch off the earthen floor in the stone cellar by means of small blocks.

On 22nd November the hive weighed 49 pounds. No sound could be heard in it all winter. On 15th April the bees were found all dead on the bottom board and appeared to have died early in the winter, as scarcely any honey was consumed and the combs were dry and clean. Weight on 15th April, $47\frac{1}{4}$ pounds. It is plain that this plan cannot be recommended.

Experiment No. 5.—One colony was placed in a packing case large enough to allow of 4 inches of cut straw and chaff being packed all round the hive, and the box was left out of doors in a sheltered place on the ground in the yard. Bottom board loosened and 1-inch blocks put at each corner between bottom board and brood chamber. Wooden cover also replaced by 4-inch chaff cushion, and box filled up with 4 inches of chaff and cut straw. No ventilation.

The case was, besides, buried under a foot of snow shovelled upon it. No sound could be heard from this hive during the winter till it was taken out on 15th April; the weight had been reduced from 57 pounds in November to $49\frac{1}{4}$ pounds, the bees having consumed $7\frac{3}{4}$ pounds. On being taken out, the hive was found very wet and mouldy with a thickness of about two inches of dead bees on the bottom; two frames only were partly filled with bees. Water had evidently come in from the outside, which would have been avoided if the hive had been raised about one foot from the ground, and the results might then have been much better.

On 1st May the bees from this hive were gathering pollen, but were few in number. May 14:—Colony very weak, but queen apparently in good condition; two frames with brood and eggs and new honey. June 1:—Hive deserted, though plenty of stores remaining; $11\frac{1}{2}$ pounds of new honey in the brood chamber.

Experiment No. 6.—One colony packed exactly as No. 5, but with ventilating shaft from entrance to the outside of the case which was placed three feet from the ground on the top of an empty case out of doors.

No sound could be heard from this hive all winter up to the 1st April, when a slight hum was perceptible. On 8th April the first bees made their appearance, some flying in the evening; there were many dead bees at the entrance; outside temperature, 44° F. From the 8th to 14th April, on warm days, a few bees were noticed flying. On 15th April the hive was taken out of the packing case and found to be deserted; many dead bees lay at the back end of the hive: the frames above were all dry and clean.

The hive when put into the case on 22nd November, weighed 51 pounds; when taken out on 15th April, $39\frac{1}{4}$ pounds, $11\frac{3}{4}$ pounds of honey having been consumed.

Conclusions:—The mode of wintering that has given most satisfaction is No. 1.

Hives put in the cellar as they came from the bee-yard with the tops and bottoms on (No. 2), had not sufficient ventilation. Dampness caused dysentery.

In the hive packed in saw-dust with no ventilation (No. 4,) the bees were smothered; in the hive similarly treated but with ventilation (No. 3,) the colony was much weakened by heat, dampness and insufficient ventilation.

The hives packed in chaff and left out of doors, one on the ground without ventilation (No 5) and the other with a ventilating shaft (No. 6), seem to have both been

insufficiently protected with packing, but the former one probably suffered most from the water that found its way into the hive.

The temperature of the cellar during the winter 1895-96 was:—

November	38° to 40° F.
December	40° to 44° F.
January	38° to 44° F.
February	38° to 43° F.
March	40° to 41° F.
April	40° to 47° F.

Season of 1896.

April 13, 1896.—The weather being very fine, bright and calm (temperature in the cellar 42° F., out of doors, 55° to 59° F.), three hives were taken out of the cellar at noon and placed on their summer stands, which were set on about one foot of snow. The bees began to fly at once, but at night there was a considerable number of dead bees about the entrances.

" 14.—Weather very cool; very little flying.

" 15, 16.—Very warm, bees actively gathering pollen on willows in the swamps.

" 16.—Remaining colonies taken out. Temperature in cellar 47° F.; out of doors, 75° to 78° F.

" 16–30.—Bees working well, gathering pollen on willows and soft maples. Some bees seen attempting to rob; entrances of threatened hives were contracted so that only one bee could pass at a time.

May 1–7.—Bees gathering pollen. Two days were cold and windy; some dead brood was carried out before the entrance of the hive.

" 8–13.—Bees began to work on cherry and plum blossoms.

" 13.—Apple blossoms provide abundance of pollen and honey.

" 14.—Dandelions in full bloom and very attractive to bees.

" 15–20.—Very fine; bees working well.

" 20.—White flowers of *Viburnum Lantana* covered with bees gathering honey.

" 20–31.—Bees working well; buckthorn hedges (*Rhamnus frangula*) thronged with them. This, like the *Viburnum*, appears to be a very valuable shrub for bees, as it comes in bloom so early in the season, before the clovers. Both these shrubs, especially the buckthorn, make also good and useful hedges and can be grown from seed.

June 4.—Bees clustering for the first time. Removed all cushions and propolis quilts. Placed supers on all hives requiring them.

" 5.—Clover and Mock Orange (*Philadelphus*) beginning to bloom.

" 13.—First swarm of the season.

" 19.—Bee-moth grubs found in some of the hives, of which the colonies had died or deserted in the spring. These hives were taken into a closed room, and fumigated with sulphur. For this purpose the brood chambers, after removal of the top and bottom, were piled on the top of each other, and raised sufficiently from the floor to allow of an iron vessel standing on legs, containing half a pound of sulphur to be placed under the lowest; the sulphur was ignited, and the fumes rose through all the frames and killed every grub.

" 22.—Inspected every hive; a considerable number of sections were capped.

July 1.—First honey taken off from the hives this season.

" 3.—Noticed bees very thick on mustard and basswood, of which the blossoms are just opening. Marked all supers, and removed those that were full.

" 21.—Bees working still on clover and basswood, and beginning on the English horse-beans.

" 23.—Basswood blossoms just finished.

" 24.—Noticed bees abundantly attracted by the following flowering plants:— *Asclepias tuberosa, Aster sibiricus, Centaurea macrocephala, Linaria spectabilis, Veronica spicata.*

July 26.—Bees very thick on St. John's wort.
" 27.—Buckwheat plot No. 1 in bloom; bees working well.
Aug. 4.—Workers first noticed killing drones.
" 6-18.—Very hot and dry; this weather lessened the flow of buckwheat nectar considerably, so that the bees worked on this plant only early in the morning.
" 18-Sept. 1.—Weather very fine, with occasional showers; bees flying well, but no increase in weight of honey.
Sept. 1.—Removed all supers, and weighed brood chambers; all the hives of a weight less than 55 pounds were given extracting frames with good sealed stores, so that they might go into winter quarters weighing about 50 pounds. For this, the frames that were empty, or nearly empty, were taken out and replaced by full frames with well-capped honey. When it was not found advisable to replace the frames, but feeding was necessary, a super containing partly-filled sections, or extracting frames, was placed on the top on the propolis quilt, a corner only—about one inch—of the quilt being turned back to provide a passage for the bees, so as to make the bees believe they were taking the honey from another hive. It is important to uncap the whole of the sections or frames in the super, or the bees will not take the honey down to their own combs so readily. If this mode of feeding is followed, there is little danger of the bees robbing.

The above excellent plan of placing a quilt under the super, as explained above, was suggested to me by Mr. William McEvoy, of Woodburn, Ont., Foul Brood Inspector, and proved perfectly successful. This plan prevents robbing, and uses up any sections which may be only partially filled.

Those who have no extra sections or frames of honey should feed granulated sugar of the best quality, two parts, by measure, in water, one part. The water should first be boiled and then, while still on the stove, kept thoroughly stirred while the sugar is put in and until all is dissolved. This syrup is to be fed lukewarm, great care being taken not to allow any to leak or be spilt around in the hive. We generally use a Miller feeder.

Buckwheat.

Two plots of Silver-hulled buckwheat were sown last season on the Experimental Farm, primarily as pasturage for the bees, but also for the grain.

Plot No. 1.—The ground was partly sandy, partly clay loam. A dressing of wood ashes—about 150 bushels to the acre—was applied during the early part of the winter and ploughed under in spring. The buckwheat was sown on 20th June, three pecks to the acre. It came up 27th June, was in bloom 26th July, when the bees began at once to work on it; its growth was strong and even, and the seed was ripe on 25th September. A heavy frost on 22nd September injured this plot so that it was of no further use for the bees. Yield of threshed grain per acre, 29 bushels 26 lbs.

Plot No. 2.—Soil similar. Sown, 29th June; came up, 5th July; in bloom, 30th July and 1st August, when the bees began at once to work on it; it made a strong and even growth. It was injured by frost on 22nd September, and cut on 25th September. Yield of grain per acre, 23 bushels 32 lbs.

Five-Banded Italian Bees.

There is in the apiary but one colony of pure Five-banded Italian bees. It has again this year given very good returns. It was one of the colonies of the wintering experiment No. 1, and came out of winter quarters fairly strong, having consumed only 7½ pounds of honey. During the summer it made 20 sections of honey and 53 pounds of extracted honey, and swarmed once in July. A swarm from another hive, which came out at the same time, was very much mixed with this one, but the Italian queen came through safely. These two swarms together made 22 sections and 37½ pounds of extracted honey.

Hive in a Wood Shed.

Many inquiries having been received from the city, where space is scarce, about the possibility of keeping bees in sheds, we tried last season by placing one in a wood shed. A small hole, 6 inches by 6, was cut in the side wall of the shed, on a level with the floor, facing the south. The entrance of the hive was close to this. From 15th April to 1st May bees from other hives tried very hard to rob this hive; so the entrance was contracted so as to allow only one bee to pass in and out at a time. This hive and the swarm which it gave produced 93 sections of honey. This hive has been left in the shed for the winter. (See Experiments in wintering, 1896-97, No. 5.)

Hive Kept on Scales to Show Daily Gain.

Records of the daily weighing of one colony were kept during the summer. This was a first swarm secured on 13th June, and weighed at that date $6\frac{3}{4}$ pounds. It was put into a hive with four frames of drawn comb and four frames of foundation, placed alternately.

1st	week from	17th	June,	gain	$22\frac{3}{4}$ lbs.	
2nd	"	24th	"	"	$20\frac{1}{2}$ "	
3rd	"	1st	July	"	$12\frac{1}{4}$ "	
4th	"	8th	"	"	$15\frac{3}{4}$ "	
5th	"	15th	"	"	$15\frac{1}{4}$ "	
6th	"	22nd	"	loss		$4\frac{1}{4}$ lbs.
7th	"	29th	"	gain................		
8th	"	5th	August	"	$11\frac{3}{4}$ "	
9th	"	12th	"	loss		$\frac{1}{4}$ lb.
10th	"	19th	"	"		2 lbs.
11th	"	26th	"	"		1 lb.
					$98\frac{1}{4}$ lbs.	$7\frac{1}{2}$ lbs.

Making a total gain in weight of $90\frac{3}{4}$ pounds. Ninety-four sections of honey were taken from this hive. Some of the difference represents the weight of brood, &c.

The largest gain on any one day was $6\frac{1}{4}$ pounds, on two occasions, one during the clover flow and the other during the basswood flow.

Returns.

The total returns of the Central Farm Apiary for the season of 1896 show an average of 50 sections, and 16 pounds and $\frac{1}{2}$ ounce of extracted honey for each colony.

The Bee Cellar.

The winter quarters are a chamber boarded off from the cellar of a private house. In former winters, it was found to be too cold and damp and the ventilation was not satisfactory. There was only an upright ventilator, 3 inches by 3 inches, passing through the ceiling up to a stove pipe, and provided with a damper with which to regulate the draught; but no air could be let in from the outside.

Several important improvements have been made in this cellar during the last summer: a cement floor, shelves and an entrance from the outside. It is also larger than before, being 11 feet 6 inches by 15 feet, which allows 3 tiers of shelves above each other, and two passages. It is boarded off from the remainder of the cellar by a partition of tongued and grooved lumber. The floor is concrete over 8 inches of small stones. The lowest shelf is 18 inches from the floor, the second 20 inches clear above, and the third again 20 inches clear above that; neither the hives on the third shelf nor the uprights supporting the shelves reach the ceiling, so that no vibrations can reach the hives from the ceiling above.

Outside air can be let in at any time by slides into both the bee-chamber and the large cellar. Adjoining the bee-chamber is a smaller one provided with ventilators and having a coal stove, so that, whenever necessary, fire can be made to raise the temperature or purify the air of the whole cellar by increasing the ventilation.

Experiments in Wintering (1896–97).

Colonies put into winter quarters, 16th November, 1896.

No. 1.—A repetition of experiment No. 1 of the former winter, with 15 colonies of an average weight of 50 pounds and $15\frac{3}{4}$ ounces each.

No. 2.—A repetition of experiment No. 2 of former winter, with two colonies weighing respectively 49 pounds and 56 pounds.

No. 3.—Two colonies weighing $60\frac{1}{2}$ pounds and 63 pounds were placed in the root house of the Central Experimental Farm, which is 100 feet long, 25 feet wide and 10 feet deep. They are on a shelf nailed up against the side wall about 3 feet from the ceiling and projecting about 2 feet. A curtain is hung from the wall over the top and front of the hives, so as to keep out all the light. The propolis quilt of one of these hives had been removed on 2nd November and a cushion put in in its place. That of the other hive has been left and a cushion placed above it, but the front of the hives has been raised half an inch more by means of an inch block in the middle of the entrance.

No. 4.—Two colonies weighing 50 pounds and 52 pounds, have been put into a pit dug in the side of a hill 3 feet deep by 3 feet in width and 10 feet long, so that the ventilators at both ends should not be immediately above the hives which are in the middle of the pit. The hives rest on two cedar poles laid along the full length of the pit. A third cedar pole of the same length is laid in front of the entrance of the hives and insures the necessary circulation of the air from the ventilators. These ventilators which are 3 inches by 4, are made of boards, three of which reach down to the bottom of the pit, the fourth only to the top of the pit, and they rise 3 feet above the ground.

In each hive half-inch strips of wood have been laid under both sides and under the back end, between the brood chambers and the bottom boards, so as to provide more space at the bottom of the hive in case a quantity of dead bees should accumulate there.

The pit is filled up with loose straw up to four inches from the top, which is made of cedar poles along the length of the pit, the middle ones higher than the others, covered with a layer of straw and one foot of soil.

A small shaft has also been arranged between the hives, down which a thermometer can be let by means of a string, so that the temperature of the pit may be ascertained. The thermometer is examined once every week. If the temperature rises too much, some of the covering may be removed; and if the contrary, some may be added.

No. 5.—Two colonies, weighing 54 pounds, and 63 pounds., were put in a wood shed, the walls of which are double boarded, with an air space of four inches. The floor, which is about one foot from the ground, is also double-boarded, and there is no draught under it. The hives are about one foot from the wall, resting on a double thickness of sacks laid on the floor, and are covered above and all round with a double thickness of the same sacking. No ventilation is provided for one hive. For the other, which is the one that was kept in the shed during the summer, a small shaft, $\frac{1}{2}$-inch square, extends from the opening of the hive to the outside of the shed, and $\frac{1}{2}$-inch strips of wood are put under both sides and under the back end, between the bottom boards and the brood chambers, so as to give more space at the bottom of the hive in case a quantity of dead bees should accumulate there.

A Few Suggestions to Beginners in Apiculture.

Locate your bee-yard in a well sheltered place, where no cold wind can chill the brood. It will pay to build a high board fence if you cannot provide shelter in any other way.

Have no high trees near the apiary, for it is very difficult to get the swarms down from them.

View of the Apiary at the Central Experimental Farm, Ottawa.

Shade may be obtained by the use of a second cover to the hives, made of boards one foot wider and one and a half feet longer than the cover of the hive.

Do not use propolis quilts during the honey season

Do not allow your sections to be travel-stained by leaving them in the hives too long; remove them to a warm room.

If the outside sections are not well filled, put them back in the next super.

Use 4-piece sections in preference to 1-piece sections.

Use full sheets of foundation in your sections; the bees will go up sooner and work better on full sheets.

In the same way, in the brood chamber use full sheets of foundation; this will be found a saving of time and do away with much drone comb.

Wire all brood frames and extracting frames.

Always sort your sections and clean them thoroughly before sending them to customers. Send them always in a clean super or in a neat crate.

Let the bees always have a supply of water as near as possible to the apiary, for in cool weather they require a great deal of water, especially when they are rearing a brood or if the honey flow is light.

Always handle your bees with the greatest care and gentleness.

JOHN FIXTER.

REPORT UPON FURTHER EXPERIMENTS WITH CERTAIN BRANDS OF COMB FOUNDATION, BY FRANK T. SHUTT, M.A., F.I.C., CHEMIST, DOMINION EXPERIMENTAL FARMS.

This investigation, commenced in 1894, and continued from year to year since that date, has for its chief object the determination of the relative usefulness in comb building of certain brands of "foundation." It was supposed that those brands of wax of which the bees used the most, or, in other words, to which they added the least amount of wax, in the building of the cell walls, would prove to have the greater value to the bee-keeper. It is argued by most practical bee-keepers that, in supplying the bees with wax that they can readily draw out and utilize in cell formation, a greater store of honey may be expected. This, indeed, seems to be the main reason for furnishing bees with artificial comb, though there are others of perhaps somewhat less importance. On the other hand, however, there are some bee-keepers who think that there is but little advantage in this respect, the chief benefit being a more regular structure of the cells in the section. At my suggestion, Mr. R. F. Holtermann, editor of the Canadian Bee Journal, has kindly furnished the following statement respecting the objects to be attained in supplying the bees with comb foundation :—

"As to the object of using comb foundation, brood foundation is used to save the bees time and material, to get all worker cells, and to secure straight comb. The foundation in the sections is first of all to aid in enticing bees into the supers, to save them material by the giving of wax, to save time, as they can begin storing more quickly in the supers; also to get an evenly-filled section, and to have it attached to the sides and bottom of section. Bees are much less likely to do this well when they build the comb themselves. Again, it is desirable to have the cells of a uniform size; by giving them the foundation, this is secured."

In connection with the question of wax utilization and deposition, Mr. Holtermann is also of the opinion that bees utilize the wax in the foundation to a greater extent when the honey flow is light; in other words, that, when gathering large quantities of honey, bees manufacture or produce more wax than when the honey supply is light. It might be urged that this argument, carried to its logical conclusion, would in a large measure go to show that, in seasons of a heavy honey flow, there is little economy in supplying foundation. In these considerations, the fact must not be lost sight of that wax is not a material gathered by the bees, but a true secretion, the result of the physiological functions of certain glands in the bee, and is produced to a large

extent at the cost of the honey consumed by the insect. Wax, is, therefore, in a sense, a physiological concomitant of honey, and consequently it is improbable that all the wax necessary for the construction of the comb can be furnished the bees; indeed, our past results all point in this direction. It is, however, at the same time true that a portion of this wax can be economically supplied in the foundation, and within certain limits it would appear that the wax added by the bees is inversely proportionate to that furnished as foundation. I am further inclined to the belief that the weight of the comb varies somewhat with the season; the reason for this may be accounted for by Mr. Holtermann's theory already referred to.

For the details of the method of procedure, the reader is referred to page 171, Report of the Experimental Farms for 1895. An additional experiment has, however, been made this year, namely, that of ascertaining directly the weight of foundation after it had been drawn out by the bees. This was done by carefully shaving away the empty cells on both sides till the foundation was left. The great difficulty experienced in doing this with any degree of accuracy, owing to inequalities and to the fact that the foundation is not always in one plane, renders the results but approximate. Indeed, it will only be from oft-repeated experiments in this matter that safe conclusions can be drawn.

In Table I, we present in detail the data showing the weight and percentage of wax added by the bees in building the comb:—

TABLE I.

EXPERIMENTS with various Brands of "Foundation," 1896.

Designating Letters.	Name of Wax and Mill.	Section.	Milling Temperature.	Weight in grammes of "Foundation," 2 inches square.	Weight in grammes of empty honey-combs, 2 in. square.	Weight in grammes of wax added by bees per 2 in. square.	Percentage of wax added by bees.	Gathered from
			F.					
A 1	Choice wax, Root mill..	Outer	89°	1·401	2·655	1·254	89·5	Clover.
A 2	" "	Inner	89°	1·401	2·735	1·334	95·2	"
B 1	" "	Outer	120°	1·204	2·691	1·487	123·5	"
B 2	" "	Inner	120°	1·204	2·647	1·443	119·9	"
C 1	Foundation in general use, 1896	Outer	.....	1·215	2·946	1·731	142·4	"
C 2	" " "	Inner	.....	1·215	3·003	1·788	147·1	"
D 1	" " 1895	Outer	.....	1·215	2·761	1·546	127·3	"
D 2	" " "	Inner	.....	1·215	2·700	1·485	122·2	"
D 3	" " "	Outer	.....	1·215	3·082	1·867	153·6	Buckwheat.
D 4	" " "	Inner	.....	1·215	3·182	1·967	161·9	"
E 1	Heavy sheet, Root mill	Outer	120°	1·315	3·062	1·747	132·8	Clover.
E 2	" "	Inner	120°	1·315	3·069	1·754	133·3	"
F 1	Inferior wax, Root mill	Outer	89°	1·224	2·823	1·599	130·6	"
F 2	" "	Inner	89°	1·224	2·771	1·547	126·3	"
G 1	" "	Outer	120°	1·167	2·664	1·497	128·2	"
G 2	" "	Inner	120°	1·167	2·666	1·499	128·4	"
H 1	Choice wax, Given process	Outer	.....	1·801	3·538	1·737	96·3	"
H 2	" "	Inner	.....	1·801	3·567	1·766	98·0	"
I 1	Poor wax, Given process	Outer	.....	1·582	3·739	2·157	136·3	"
I 2	" "	Inner	.....	1·582	3·771	2·189	138·3	"
J 1	Patent process, 12 sq. ft. per lb	Outer	.....	1·004	3·193	2·189	218·0	"
J 2	" " "	Inner	.....	1·004	3·311	2·307	229·7	"
K 1	" 15 sq. ft. per lb	Outer	.....	1·093	3·555	2·422	221·6	"
K 2	" " "	Inner	.....	1·093	3·329	2·236	204·6	"
L 1	Heavy sidewall, R. F. H.	Outer	.....	1·257	2·792	1·535	122·1	"
L 2	" "	Inner	.....	1·257	2·875	1·618	128·7	"

Although in some instances there would appear, comparing the above results with those of last year, to have been less wax added than in 1895, there are so many exceptions that no conclusions can be safely drawn, either as regards variation in weight of

wax deposited or its possible causes. The foundation supplied was from the same stock as that in previous years and consequently the same weight for the 2 inches square of foundation were used. The "percentage of wax added" by the bees, therefore, varies with the "weight of wax added".

The differences between the weights of wax added in the outer and inner sections is so small that the argument that the cell walls of the outer sections are stouter and heavier than those of the inner sections, receives no support from these data. This conclusion is practically identical with that reached in last year's experiments.

It is to be noted that in the case where very light foundations were used, as in *J* and *K*, the weight of wax added was much greater than when heavier brands were supplied.

As reported last year, the weight of wax added when the honey was collected from buckwheat is greater than in that deposited for clover honey.

With respect to the appearance of the comb from different brands of foundation, it was noticed as heretofore that the dark or deep yellow varieties produced unsightly "fishbones," which would materially affect the sale of the honey in the comb.

Since the chief object in this investigation was to ascertain the relative ease with which the wax of the various brands of foundation could be drawn out or utilized by the bees, and the above method of procedure not proving altogether satisfactory, it was thought that, at all events, approximate results could be obtained by weighing the foundation after the empty cells had been shaved away on both sides of the foundation, and subtracting the weight thus found from that of the same area of foundation as put into the section. The figure thus obtained would represent the weight of wax drawn out from the foundation supplied and utilized by the bees in building the cell walls.

The data in Table II, resulting from this method of experiment are:—

TABLE II.

EXPERIMENTS with various Brands of "Foundation," 1896.

Designating Letter.	Name of Wax and Mill.	Section.	Milling Temperature.	Weight in grammes of "Foundation," 2 inches square.	Weight in grammes of "Foundation" after removal of cells.	Weight in grammes of "Foundation" wax utilized by bees.	Percentage of "Foundation" wax utilized by bees.	Gathered from
			F.					
A 1	Choice wax, Root mill	Outer	89°	1·401	·702	·699	49·9	Clover.
A 2	" "	Inner	89°	1·401	·641	·760	54·2	"
B 1	" "	Outer	120°	1·204	·835	·369	30·6	"
B 2	" "	Inner	120°	1·204	·77	·434	36·0	"
C 1	Foundation in general use, 1896	Outer	......	1·215	·842	·373	31·0	"
C 2	" " "	Inner	......	1·215	·741	·474	39·0	"
D 1	" " 1895	Outer	......	1·215	·81	·405	33·3	"
D 2	" " "	Inner	......	1·215	·821	·394	32·4	"
D 3	" " "	Outer	......	1·215	·765	·450	37·0	Buckwheat.
D 4	" " "	Inner	......	1·215	·747	·468	38·5	"
E 1	Heavy sheet, Root mill	Outer	120°	1·315	·856	·459	34·8	Clover.
E 2	" "	Inner	120°	1·315	·900	·415	31·6	"
F 1	Inferior wax, Root mill	Outer	89°	1·224	·803	·421	34·4	"
F 2	" "	Inner	89°	1·224	·774	·450	36·8	"
G 1	" "	Outer	120°	1·167	·726	·441	37·8	"
G 2	" "	Inner	120°	1·167	·712	·455	38·9	"
H 1	Choice wax, Given process	Outer	......	1·801	1·187	·614	34·0	"
H 2	" "	Inner	......	1·801	·988	·813	45·1	"
I 1	Poor wax, Given process	Outer	......	1·582	1·107	·475	30·0	"
I 2	" "	Inner	......	1·582	1·135	·447	28·3	"
J 1	Patent process, 12 sq. ft. per lb.	Outer	......	1·004	·875	·129	12·8	"
J 2	" " "	Inner	......	1·004	·891	·113	11·2	"
K 1	" 15 sq. ft. per lb.	Outer	......	1·093	1·014	·079	7·2	"
K 2	" " "	Inner	......	1·093	·853	·240	21·9	"
L 1	Heavy sidewall, R. F. H.	Outer	......	1·257	·793	·464	36·9	"
L 2	" "	Inner	......	1·257	·761	·496	39·4	"

The weight of wax utilized by the bees from 2 inches square of foundation varies from ·079 grams to ·813 grams. The latter amount of wax was taken by the bees from the heaviest brand of foundation supplied, while the former was from the lightest brand. If we exclude the heaviest and lightest foundations, however, it will be seen that the amounts of wax utilized in cell formation are not subject to much variation, though it should be remembered that the method employed did not allow of any great degree of accuracy in the determination. It will, therefore, be wisest to consider average results before making deductions.

A study of the data of *A 1, A 2, B 1, B 2*, might appear to favour the view that the milling temperature exercised an influence upon the relative ductility of the wax and go to show that wax made at 89 degrees F. is more easily drawn out than that milled at 120 degrees F. This view, however, receives no corroboration from *F 1, F 2* and *G 1, G 2*,—a parallel case; and I am inclined to the belief that the larger amounts utilized in *A 1, A 2*, are due to the foundation supplied being heavier than *B 1, B 2*, (see table.)

On calculating the "per cent of wax added," it becomes apparent that in 18 cases (or 70 per cent of the trials made) this percentage was between 30 and 40; in three trials, more than 40 per cent, and in 5 instances, less than 30 per cent. As remarked in considering the "weight of wax added," the higher numbers were obtained from the heavier foundations.

Table III, which presents the averages of the foregoing data, was prepared for the purpose of making clearer the features already alluded to and to assist in the more ready comparison of the data from the various brands.

Table III.

Table of Averages, 1896.

Designating Letter.	Name of Wax and Mill.	Milling Temperature.	Average weight in grammes of 2-in. sq. of empty comb.	Average weight in grammes of wax added by bees.	Average percentage of wax added by bees.	Average weight in grammes of "foundation" after removal of cells.	Average weight in grammes of "foundation" wax utilized by bees.	Average percentage of foundation wax utilized by bees.
		F.						
A 1, *A* 2	Choice wax, Root mill.	89°	2·695	1·294	92·3	·671	·729	52·0
B 1, *B* 2	" "	120	2·669	1·465	121·7	·802	·401	33·3
C 1, *C* 2	Foundation in general use, 1896	....	2·974	1·759	144·7	·791	·423	35·0
D 1, *D* 2	" " 1895	......	2·730	1·515	124·7	·815	·399	32·8
D 3, *D* 4	" " 1895	......	3·132	1·917	157·7	·756	·459	37·7
E 1, *E* 2	Heavy sheet, Root mill	120°	3·065	1·750	133·0	·878	·437	33 2
F 1, *F* 2	Inferior wax, "	89°	2·797	1·573	128·4	·788	·435	35·6
G 1, *G* 2	" "	120°	2·665	1·498	128·3	·719	·448	38·3
H 1, *H* 2	Choice wax, Given process	......	3 552	1·751	97·1	1·087	·713	39·5
I 1, *I* 2	Poor wax, "	. ..	3·755	2·173	137·3	1 121	·461	29·1
J 1, *J* 2	Patent process, 12 sq. ft. per lb.	....	3·252	2·248	223·8	·883	·121	12·0
K 1, *K* 2	" 15 "	......	3·442	2·329	213·1	·933	·159	14·5
L 1, *L* 2	Heavy sidewall, R. F. H	......	2·833	1·576	125·4	·777	·480	38·1

There would not appear to be any definite relation between the weight of wax added and that of the wax utilized, though the data of *I 1*, *I 2*, and *K 1*, *K 2*, make it evident that in very light foundations the amount of wax utilized is very small and the amount added correspondingly large. This would point to economy in supplying heavier foundations than the brands just referred to, if the question resolves itself into one of furnishing wax that can be utilized by the bees.

The average weight of "foundation" after the removal of the cells, is, all things considered, seen to be fairly constant. The greatest weight was from "Choice Wax, Given Process"—the heaviest foundation experimented with—, the least weight was obtained from "Choice Wax, Root Mill, temperature 89 degrees F." by no means the lightest brand used, but the brand from which the bees utilized the most wax.

In considering the average weight of foundation wax utilized, the largest amounts were from *A 1*, *A 2*, and *H 1*, *H 2*, the Choice Wax of the Root Mill and Given Process, respectively. The least amounts so utilized were from "Patent Process" 12 square feet and 15 square feet per pound.

In summing up the results of this year's work, we may conclude that, considering the values of the comb foundations to be dependent upon the extent to which they are utilized by bees in cell formation, the Choice Wax, Root Mill, temperature 89 degrees F., gave the best, and the "Patent Process," 12 square feet and 15 square feet per pounds, the poorest results. Both the Choice and Poor Wax of the "Given Process" give very heavy "fishbones." Concerning the other brands on these points, the differences are not sufficiently well marked to allow of any emphatic statement being made respecting them.

F. T. SHUTT.

NOXIOUS WEEDS.

The subject of weeds is one of burning interest all over Canada, and is too large to treat exhaustively in this place. Farmers, as a rule, are not well informed even with regard to the common species of aggressive weeds occurring on their land. Figures have already been given in former reports of some of the plants, the appearance, name and nature of which it was important, from their injuries, should be known so as to be eradicated whenever noticed. I submit herewith a figure of one of the new pests of Manitoba, namely the Cow Cockle (*Saponaria Vaccaria*, L.), also known locally under the different names of Cow Herb, China Cockle and Soapwort. This plant has been noticed as an aggressive enemy in field crops only during the last two years, and so far only in the province of Manitoba, where it has spread very rapidly, particularly in the Mennonite settlements and other parts of Manitoba, the pretty porcelain-pink flowers sometimes occurring in such numbers as to give a reddish tinge to many acres of crop. The Cow Cockle belongs to the Pink or Carnation family. It is an annual herb with pale green, fleshy, sessile leaves, borne in pairs at each joint of the stem. The flowers first appear in Manitoba in July; they are about ¾ inch in diameter and are borne in large numbers, but each singly at the end of the thread-like branchlets of the many times divided flowering stems, as shown in the excellent figure herewith, which is engraved from a photograph taken by Mr. R. G. Mackay at Indian Head. Strong plants will frequently grow over two feet in height, with a diameter almost equal. The smooth

pod is inclosed in a five-angled calyx which enlarges with it. When the seeds are ripe the apex of the pod opens, forming a four-toothed orifice. Each of the pods with its enveloping five-winged calyx, measures about ½ inch in diameter, and contains an average of 16 round, black, slightly roughened seeds. This plant, together with the Tumbling Mustard (*Sisymbrium altissimum*, L. ;=the *S. sinapistrum*, Crantz, of former reports), Ball Mustard (*Neslia paniculata*, Desv.), Hare's-ear Mustard (*Erysimum orientale*, R. Br.*), and False Flax (*Camelina sativa*, Fries.), has spread with almost incredible

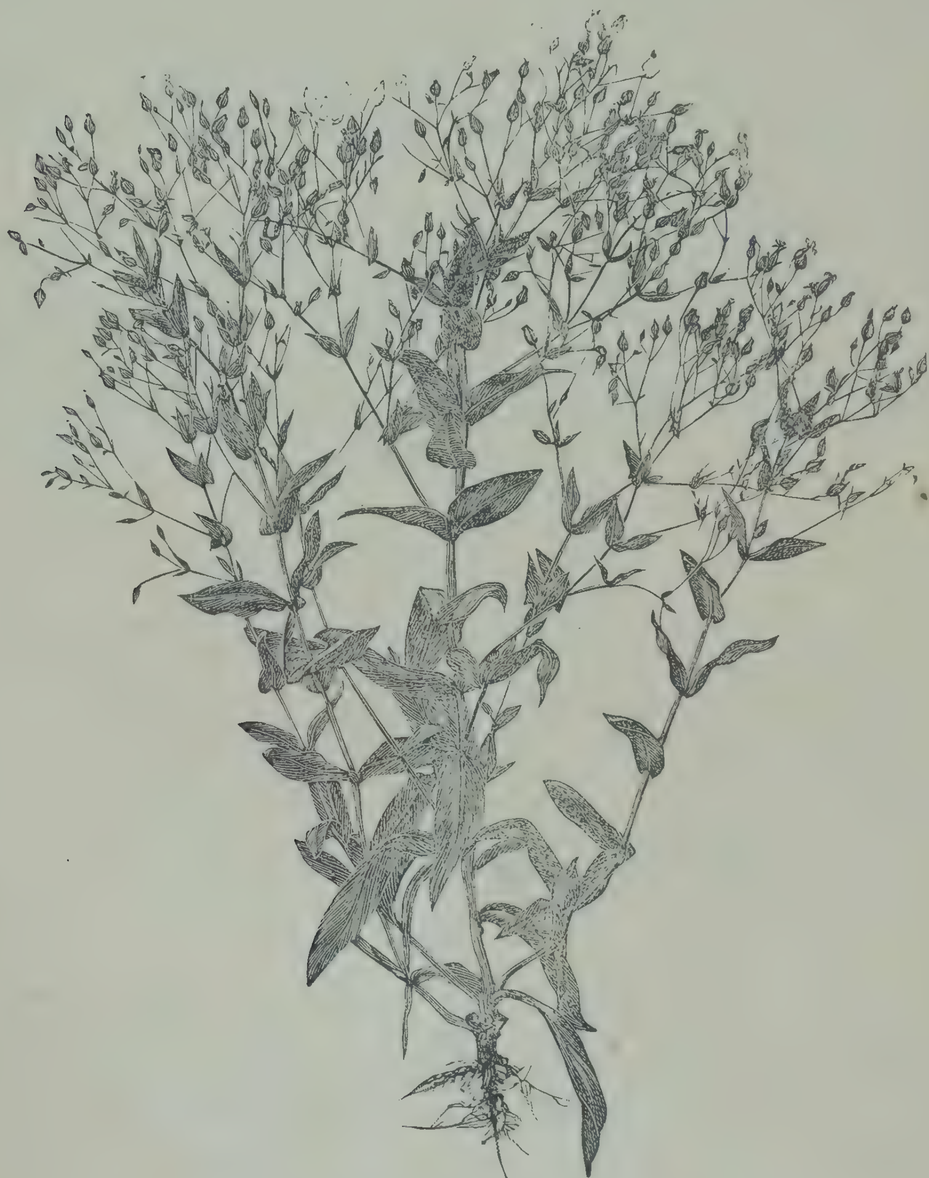


Fig. 18.—Cow Cockle.

rapidity through the wheat-growing districts of Manitoba and the North-west Territories. The indications are that all of these were introduced from Europe in flax seed, and, although in the case of the Cow Cockle and Ball Mustard, there was little in their appearance from which it might been anticipated that they would become troublesome, the rapidity with which they have spread shows how important it is that every one of these plants should be destroyed by hand pulling or summer fallowing as soon as detected on land in a new locality.

*This plant is now known under the name of *Conringia orientalis* (L.), Andrz. *Conringia* is quite a different genus from *Erysimum* and certainly should be separated from it.—J. F.

AUTHOR'S EDITION

FROM ANNUAL REPORT ON EXPERIMENTAL FARMS FOR THE YEAR 1898

CANADA

DEPARTMENT OF AGRICULTURE

CENTRAL EXPERIMENTAL FARM

REPORT OF THE ENTOMOLOGIST AND BOTANIST

(JAMES FLETCHER, LL.D., F.R.S.C., F.L.S.)

1898

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1899

INDEX

REPORT

OF THE

ENTOMOLOGIST AND BOTANIST

(JAMES FLETCHER, LL.D., F.R.S.C., F.L.S.)

1898.

DR. W. SAUNDERS,
Director, Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to hand you herewith a report on some of the most important subjects which have been brought officially under my notice during the past season.

As in former years it is, of course, impossible and unnecessary to treat in the annual report of the Division of many subjects which have required attention by the Entomologist and Botanist and his Assistant during the year. The correspondence has increased considerably and is of a varied character; there were 2,771 letters received and 2,906 sent out.

I have had several opportunities of studying important outbreaks of injurious insects and noxious weeds in the field and of attending meetings in widely separated parts of Canada, where it has always been my endeavour to bring prominently before farmers the work which is being done for them in my Division. These occasions have been of inestimable service to me in learning the different conditions prevailing and the methods of farming in vogue in the various parts of the Dominion.

The experiments with grasses and fodder plants have been continued and are always of great interest to visitors. It is satisfactory to be able to record the great success which has attended the extensive introduction of Awnless Brome grass into the arid regions of the West. Where it has been tried in the East it is also spoken of very highly and is a heavy producer of excellent fodder and hay.

McIver's Rye-grass or Western Rye-grass, a form of *Agropyrum tenerum*, Vasey, found wild in Manitoba and cultivated for some years by the introducer, Mr. K. McIver, of Virden, Man., has given most satisfactory results as a hay and pasture grass. Mr. S. A. Bedford, Superintendent of the Brandon Experimental Farm, who has grown it for many years has always spoken of it in the highest terms. This is also the case with Mr. Angus Mackay, at Indian Head, and with some others who have tried this grass.

Of many mixtures for permanent pastures, grown together under the same circumstances, that known as the Experimental Farm Mixture has again given the best results. This mixture consists of: Timothy, 6 pounds, Meadow Fescue, 4 pounds; Orchard-grass, 2 pounds; Kentucky Blue-grass, 1 pound (where the ground is low, add 1 pound of Red Top); with the above sow the following clovers: Common Red, 1 pound; Mammoth Red, 1 pound; Alsike, 2 pounds; Lucerne, 2 pounds; White Dutch, 2 pounds. The above quantity of seed is for one acre.

Some rather important experiments have been begun along the Ottawa River in the province of Quebec to utilize the swampy lands in places subject to denudation or drowning out during the spring freshets. Mr. C. D. Tylee, of Ste. Thérese de Blainville,

has been very successful in seeding down some land of this nature which had been broken up and from which the surface soil was carried away or much impoverished by the overflowing of the river in spring.

Another series of experiments is being carried on at the suggestion of Dr. T. Christie, M.P., near Lachute, where there is now a large tract of shifting sand, some five miles in length by about half a mile to one mile in width. The provincial Government of Quebec has encouraged the farmers and assisted them in planting trees. Many of these have done well, and the farmers being all interested are working hard to bring back this tract to what it was only fifty years ago, a beautiful undulating forest land. For the last few years the desert tract has spread very much, the shifting sand drifting over good farm lands and rendering them useless. Several sample packages of seed of the Awnless Brome-grass have been distributed, which it was advised to mix with white clover and sow among the trees. As this land was within quite recent times covered with trees and as all the farmers around it are keenly interested, there is every reason to hope that if all will keep on doing a little every year, planting trees and sowing grass and clover, in time the encroachments of the sand will cease, and the land will be brought back again to usefulness.

Several thousand specimens of plants and insects have been sent in for identification from naturalists in all parts of the Dominion. From these collections several additions have been made to the museum. Many rare and valuable specimens have been added through the kindness of Mr. J. R. Anderson, the Deputy Minister of Agriculture for British Columbia, and from my own collections in British Columbia and the Rocky Mountains during the past summer.

Subjects requiring special attention since I last reported were the following :—

The Rocky Mountain Locust and wheat insects among the enemies of cereal crops; these are treated of fully in this report. Root maggots did much harm throughout the season to cabbages, turnips, radishes and onions.

Of fruit insects, particular mention may be made of the San José Scale and many other scale-insects sent in by correspondents who had noticed them in looking for the San José Scale. The efforts which have been made to control and prevent the spread of the San José Scale, have been so far successful that it may still be said, I believe, that none of our Canadian nurseries are infested, and, as no nursery stock is now allowed to be imported from infested countries, there is every reason to hope that Canada will soon be free from this terrible scourge of the fruit growers to the south of us.

An unusual outbreak was of the Green Fruit-worms on fruit trees in Western Ontario and on maple trees at Niagara, and near Ottawa at Aylmer and Hull, Que.

Tent Caterpillars were enormously abundant in nearly every province of the Dominion, and no important occurrence of parasites was noticed except in British Columbia, where the caterpillars died in large numbers about the time they began to spin their cocoons.

Plant-lice were very destructive to cherries, currants and turnips. This last named attack on turnips was very severe in Manitoba and also in Ontario, where it constituted one of the chief injuries of the year to field crops.

The apples in British Columbia were much injured by the Apple Fruit-miner and by a small moth which has not been much mentioned of late years but which many years ago, under the name of Plum Moth, was described as destructive to plums in Illinois. It also attacked plums as well as apples in British Columbia this year. I have no doubt that the caterpillar of this moth is the one which has frequently been erroneously referred to by British Columbian correspondents as the Codling Moth.

In the province of Quebec a serious and rather remarkable outbreak was by the Plum Curculio in apple orchards at Chateauguay Basin, the fruit being much distorted and rendered unfit for the market.

A few new insect pests must be mentioned :—

In British Columbia the larvæ of an extremely rare longicorn beetle, *Xylocrius Agassizii*, Lec., were imported as borers in the stems of young gooseberry bushes from Oregon. This insect I hope and believe is not likely to become a serious pest.

In New Brunswick the larvæ of a sawfly belonging to the genus *Lyda* occurred abundantly upon raspberries at St. John. There is no mention in literature of a similar attack, but several larvæ are wintering in our breeding jars and it is hoped that the perfect insect will be reared next spring and the species identified.

In Ontario, considerable injury was done in beds of violets, grown by Mr. J. Dunlop, the well known florist, of Toronto, by the larvæ of another sawfly, *Emphytus Canadensis*, Kirby. These false-caterpillars have been complained of occasionally in the past as attacking the foliage of pansies (*Viola tricolor*, varieties), but no great injury by them has been previously recorded.

The Bean Weevil, often mentioned as injuring stored beans in the United States, has this year been found at Strathroy in Ontario.

Meetings attended.—Under the instructions of the Hon. Minister of Agriculture and in accordance with plans made by you as Director, I have taken part in several important meetings during the past year. In January last I attended a convention of fruit growers, nurserymen and official entomologists at Washington, D.C., to discuss the question of legislation with regard to the San José Scale. During the same month, farmers' meetings were attended at Lachute and Cowansville, Que. In February, a series of several meetings was held in New Brunswick in company with Mr. W. W. Hubbard, of Sussex, N.B., and Mr. J. E. Starr, of Nova Scotia, who had just returned from England, where he had been examining into the transit and sale of Canadian fruit. This series ended with a grand convention at Fredericton. On the 24th and 25th of the month meetings were attended in Montreal and at Huntingdon, Que. On May 7th I visited Lachute to examine grass experiments. On June 15th a large farmers' pic-nic was attended at Farrelton, Que. June the 16th and 17th were spent in the Niagara district, driving with Mr. Geo. E. Fisher, the energetic San José Scale Inspector, who has done excellent work in detecting and destroying trees infested with the San José Scale.

On June the 27th I left for the West: the first half of July was spent in the province of Manitoba, holding meetings in company with Mr. Hugh McKellar, the Chief Clerk of the provincial Department of Agriculture. There is probably no one better informed as to the history of the development of Manitoba and its requirements than Mr. McKellar. I, therefore, obtained much valuable information from him with regard to the capabilities of the province. The subjects treated at the several meetings were all in connection with weeds and the legislation relating thereto. The meetings this year were held in parts of the province not visited by us during the two previous years. The subject of weeds is of great interest throughout Manitoba and the Territories. It was a great satisfaction to me to notice a decided improvement in the condition of the farms in this respect since four years ago. This must certainly be credited to the vigorous policy adopted by the Hon. Thomas Greenway, the Minister of Agriculture, and his Deputy, Mr. McKellar. A popular feature of this year's campaign was the establishment of a Weed Tent at the Winnipeg Exhibition, where large bundles of all the weeds of the province were exhibited. This tent was always under the charge of some official from the provincial Department of Agriculture, and I was able myself to be present for the first three days. This exhibit may fairly be said to have been thronged by inquiring farmers who wished to examine the specimens or brought with them weeds to be named and to get advice as to their treatment.

On July the 20th I joined Mr. J. R. Anderson, the Deputy Minister of Agriculture for British Columbia, and travelled with him continuously till August the 8th. Through Mr. Anderson's intimate knowledge of the country, no time was lost and a much larger number of meetings was held than could otherwise have been the case. He being also an enthusiastic botanist, assisted me very much in procuring many valuable specimens of rare plants. By many acts of kindness he added much to the pleasure of my visit.

On my way back to Ottawa, in response to a telegram from the Hon. J. H. Ross, Commissioner of Agriculture for the North-west Territories, I stayed off at Regina, and addressed a meeting of farmers upon weeds and their eradication. This meeting, of which Mr. Gerald Spring-Rice was chairman, was fairly well attended and considerable interest was shown in this important subject.

With the consent of the Hon. Minister of Agriculture, I had the pleasure of preparing for the Hon. J. H. Ross, a Bulletin on the Worst Weeds of the North-west Territories. This bulletin of 29 pages and containing many illustrations, has been widely distributed and has been received with favour by North-west farmers.

While in Manitoba in the beginning of July, and again on 16th August, I had an opportunity of investigating an occurrence of the Rocky Mountain Locust. The outbreak had been referred to in several newspapers, and there was much anxiety among farmers. I was pleased to be able to detect a great many parasites and to explain through the newspapers the true state of affairs; at the same time farmers in the infested district were advised what should be done to avoid a recurrence of the injuries experienced this year.

I returned to Ottawa on 20th August. On the 8th September I attended a meeting at Toronto of the new Canadian Horticultural Society, and delivered an address on fungous diseases and insect pests. The 7th and 8th of November were spent at Lachute and Ste. Thérèse examining the progress of grass experiments, and on the 9th November I attended the annual meeting of the Entomological Society of Ontario in Montreal.

Acknowledgments.—I am under many obligations to kind friends and scientific specialists for much assistance. Mention must first of all be made of my colleagues, Prof. John Macoun, and Mr. W. H. Harrington, of Ottawa, also of Rev. Dr. Bethune of Port Hope, Ont., for valuable help on many occasions, as well as of the following who have extended many courtesies and furnished me with their invaluable publications :—

Dr. L. O. Howard, United States Entomologist, and his staff at Washington, D.C.; Dr. J. B. Smith, of New Brunswick, New Jersey ; Professor W. G. Johnson, of College Park, Md.; and Professor T. D. A. Cockerell, of Mesilla Park, N. Mex., for special identification of insects ; Professor L. R. Jones, of Burlington, Vt., and Mr. J. Dearness, of London, Ont., for the identification of many plants and fungous diseases. I must again thank my kind friend, Miss E. A. Ormerod, for her continued interest in our work and much valuable advice always freely given.

In conclusion, I beg again to acknowledge the great help I receive continuously in all branches of the work of the Division from my assistant, Mr. J. A. Guignard, B.A.

I have the honour to be, sir,

Your obedient servant,

JAMES FLETCHER,

Entomologist and Botanist.

CEREALS.

The season of 1898 has been a very anxious one for the farmer in Canada. From all quarters correspondents have reported unusual climatic conditions with extremes of heat and drought or low temperatures and heavy rainfall. On the whole, the wheat crop of the Dominion at the end of the season turned out better than could have been anticipated. In British Columbia, with its diverse climates, the small grains gave good returns, particularly on Vancouver Island, in the rich lands along the Fraser River and in the Okanagan Valley. From the North-west the accounts both as to quality and yields are very satisfactory, notwithstanding almost unprecedented rains after the grain was cut. Mr. Angus Mackay, Superintendent of the Experimental Farm at Indian Head, says at the end of September: "From all parts of this district the wheat crop is better than was expected. The lowest yet reported is 28 bushels per acre on stubble land, while many have over 30 bushels per acre. The crops on summer-fallow run from 30 to 45 bushels per acre. There will be an average of from 30 to 35 bushels per acre." In the Manitoba *Crop Report* of August 22, we find: "Perhaps in no year in the history of the province has the productive nature of our soil been so noticeable as the present season. Seeding time was unusually favourable, but for a month or six weeks after seed was sown there was no rainfall. In many fields seed did not even start to grow until late in June, so that, up to the first week in July, prospects were far from promising. A change came during the second week in July, when hot, growing weather gave crops a good start.

"From that time to maturity conditions were favourable. After this, however, another six weeks of cold wet weather set in, from which the wheat suffered considerably. This loss varied much in the different sections of the province, and is variously estimated at from 1 to 33 per cent of the crop. The best reports were from the North-central, South-central and Eastern districts. In the South-west, particularly north of the Turtle Mountains, the crops suffered much from want of rain, and in restricted areas from the ravages of the Rocky Mountain Locust. Some fields never recovered, but others picked up in a most remarkable manner, giving the whole country a strange patchy aspect. The spring drought, followed by rain and growing weather, brought on a copious second growth of grain which, from lack of moisture, had been unable to germinate in the spring."

Mr. Wm. Scott, of the McKay Milling Co., Ottawa, who purchases large quantities of grain both in the Province of Ontario and in the West, says: "The wheat crop this year throughout the Province of Ontario was of exceptional quality, the grain being clean, hard and heavy, some samples grown in the Ottawa valley going 64½ pounds to the bushel. We have received from our correspondents no complaints of attack by weevil or any other insects. The wheat from Manitoba and the Territories is this year of exceptionally good milling quality. The weed question, however, is still one of enormous importance in the Prairie Provinces, and notwithstanding all that has been done, even more effort will have to be put forth by our western farmers in sowing clean seed and weeding their crops, if they hope to maintain their grades of hard wheat and to get the best prices in foreign markets."

In the Ontario *Crop Report* for November, 1898, we find: "Fall wheat: poor yields were exceptional, and large yields were common. The plumpness of the grain is frequently alluded to, in many cases the weight going over the standard and as high sometimes as 63 or 64 pounds to the bushel. Here and there only did correspondents complain of rust, midge or other injury to the crop. The yield is 24 bushels per acre. The acreage of spring wheat is only a little over one-third of that of fall wheat. The crop has been over an average in yield and the quality good."

In the eastern parts of the province of Quebec and through the Maritime Provinces the reports are less statisfactory, rust being frequently complained of; oats, barley,

rye and buckwheat were below the average. The early summer months were very favourable to growth, but the autumn being rainy and foggy had a bad effect on nearly all crops.

"Alberton, P.E.I.—The wheat was very badly rusted, totally ruined in some sections, much damaged everywhere. I never remember a season since I began to make observations when the grains were so universally rusted. The Campbell's White Chaff wheat was being pretty generally sown and this kind suffered most, although no kind was exempt. This was all the more regrettable since the whole crop was so promising. Up to the harvest all went so as to cause us to expect an extraordinary return; such a growth of straw and such fine roots we seldom see; but then came close, damp weather suited to the spread of rust, and the whole province was afflicted with the evil. Besides this we have a short crop of potatoes, and even turnips are not up to the average. The hay crop alone was good, extraordinarily so; but, owing to the great quantities everywhere available, it sells at only half figures. A very moist season like the past advances growth here in this sandy loam of the island wonderfully, if it does not continue too late; if it does, all grain crops are subject to rust. There is this to be remarked, which might well be expected, however, that in these years of blight those who farm intelligently, manure and work well the soil, escape very much better than the makeshift farmers. I would estimate the farm crops of the whole province, as follows: Wheat, a quarter crop; oats, a half crop; potatoes, a half crop; turnips, an under crop; hay, an extra crop."—[Rev. Father Burke.]

"Pleasant Grove, P.E.I., Sept. 9.—All wheat in this section, with the exception of White Russian, is a failure, with rust, maggots or blight. Harvest is about over with us now, all wheat being housed."—[Edward Wyatt.]

WHEAT INSECTS.

It seems strange that there should be so much lack of knowledge and confusion with regard to the few insect enemies of such an important crop as wheat. The different kinds of wheat insects are few in number and unlike in appearance, but there is no crop with regard to which for purposes of exact identification it is so necessary to see specimens of the pests complained of as in the case of wheat. The words weevil, fly, maggot, joint-worm, rust or blight are made to do service for almost any insect or disease which may occur. The chief insect enemies of wheat in Canada in the past have been the Wheat Midge, the Hessian Fly, the Wheat-stem Maggot, the American Frit-fly, the joint-worms, and the Grain Aphis. There are of course some others, such as wireworms, cutworms, and the Wheat-stem Sawfly, which attack the wheat plant occasionally or locally, but the above mentioned are those most frequently inquired about and which, therefore, are of most interest to wheat growers.

With regard to Wireworms, which are sometimes the cause of much injury to grain crops, unfortunately it must be acknowledged that up to the present no practical remedy has been discovered. The only agricultural treatments which have proved beneficial are late fall ploughing and sowing infested land to rye or barley which it is claimed that wireworms do not attack badly.

It may be convenient for reference to give a very brief account of each of the worst pests.

The Wheat Midge or "Weevil" (*Diplosis tritici*, Kirby).—Several small reddish maggots crowding around the grains of wheat in the ear and causing them to shrivel. Some of these when full-grown fall to the ground and pass the winter beneath the surface. Others remain in the ears of wheat and are harvested with the grain. The eggs are laid in June among the flowers of the wheat, being pushed down between the chaff by means of the long slender ovipositors of the females. There is only one brood in a season.

Remedies.—(I.) Burn all rubbish and screenings from the threshing machine. (II.) Plough deeply as soon as the crop is carried.

Formerly this insect was enormously abundant in the older provinces of Canada, so much so that wheat growing was given up in many sections. Of late years the Wheat Midge almost entirely disappeared from Ontario until the present season, and, although mentioned occasionally by correspondents, no specimens were submitted or those sent in proved to be something else. Wheat Midge injury is probably more wide-spread in the Maritime Provinces just now than in any other part of the Dominion. Mr. Wm. O'Brien, of Windsor, Hants Co., N. S., writes: "The wet weather forced the hay and grain to make very rapid growth. But the grain did not appear to fill well, especially wheat and oats. Wheat only about two-thirds filled and very much affected with weevil." At Middle River, Victoria Co., N.S., there was also slight injury by Wheat Midge.

A restricted but severe outbreak of this insect occurred during the summer of 1898 in the Niagara peninsula, Mr. A. T. Small writes:—

"Beamsville (Lincoln Co., Ont.).—I send you a packet of Wheat Midge sifted from one gallon of tailings, some from each of my two neighbours. One of these, Mr. Tufford, a reliable farmer of long experience, who remembers the Midge when it was so bad here 25 or 30 years ago and who has done most of the threshing in this locality, estimates the damage at about 25 per cent. He says that all fall wheat had Midge more or less, Dawson's Golden Chaff and Seneca suffered most. Spring wheat was not affected, but little is grown here. Goose wheat and White Fife were sown last spring."

Mr. Wolston Small, of Ottawa, who spent the summer of 1898 in the Niagara peninsula, saw the Wheat Midge larvæ "so abundant at the time of threshing that the ground beneath fanning mills was quite yellow." He reported the insect as very destructive all along the lake shore in the county of Lincoln.

Fig. 1.—The Hessian Fly—enlarged and natural size.

THE HESSIAN FLY (*Cecidomyia destructor*, Say).—This insect has been at different times the cause of serious injury to the wheat crop of all the older provinces, covering practically the same area as the Wheat Midge. The adult is a very small sooty two-winged mosquito-like fly about $\frac{1}{8}$ of an inch long (Fig. 1). The females lay their minute reddish eggs singly or in clusters on the upper side of the leaf. The young white maggots as soon as hatched work their way down to the bases of the leaves, those of the autumn brood becoming imbedded in the crown of winter wheat, and those of the summer brood at the base of the first or second joint of the stem under the leaf sheaths; there they attack the stem, weakening it so that it very easily breaks down at the point where the injury occurs.

When full-grown the outside skin of the maggots hardens and turns dark brown in colour, when they bear a very close resemblance to small, slender flax seeds, for which reason the pupal stage is frequently spoken of as the "flax seed" stage (Figs. 2 and 3). There are two broods in the season; the flies from the autumn brood which winter over in fall wheat appear in May and June, together with some of the flies from the first summer brood which did not emerge in the autumn; the flies of the autumn brood appear in August and the early part of September. The change from the maggot to

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Fig. 2.—Hessian Fly: pupa-cases or "flax seeds"—natural size and enlarged.

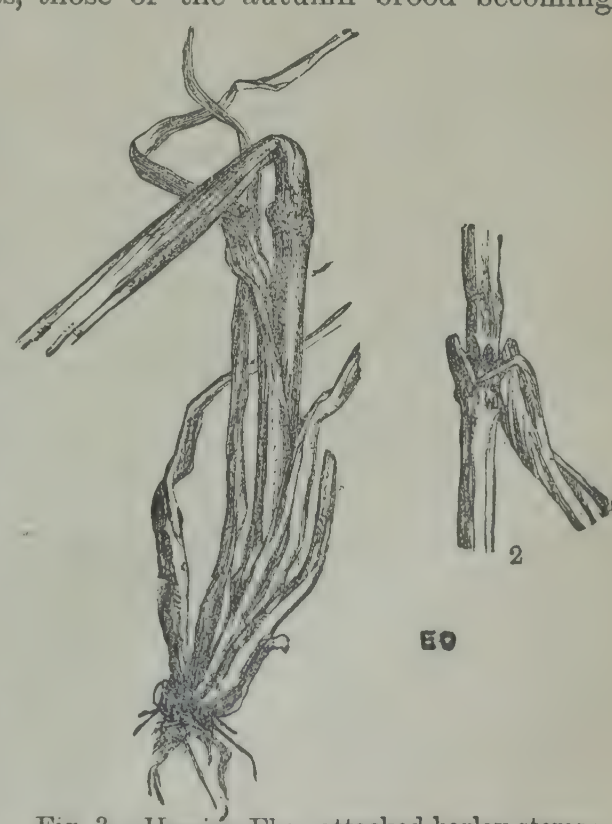

Fig. 3.—Hessian Fly: attacked barley stems: 1, elbowed down; 2, showing "flax seeds."

the pupal condition takes place inside the brown hardened skin of the flax-seed-like pupa-case a short time before the fly emerges.

Remedies.—The remedies most relied on are: (I.) Late sowing. The postponement of seeding until after the third week in September delays the appearance of the young plants above the ground until all the Hessian Flies of the second brood are dead. (II.) Burning refuse. As a large proportion of the "flax seeds" are carried with the straw and at threshing are dislodged and thrown down beneath the machine among the rubbish and broken straw, it is of great importance to destroy all rubbish or screenings wherever it is known that grain has been infested. (III.) Treatment of stubble. As soon as the crop is cut, a harrow should be run over the field so as to start a volunteer crop from the grains which have dropped in harvesting. By the time the fields will require to be ploughed, many flies of the August brood will have emerged and laid their eggs on these plants. The eggs will thus be destroyed at the same time as many seedlings of weeds, when the land is ploughed in the autumn. If fields are conveniently situated away from barns, houses and stacks, much good may be done by burning over the stubbles before ploughing, for the pupæ occur, as a rule, at the first and second lowest joints of the stem. To facilitate burning, a little dry straw may be scattered lightly over the stubble. Should the Hessian Fly ever develop as a serious enemy of wheat in Manitoba and the West, where fall wheat is not grown, burning over and ploughing down of stubbles immediately the crop is cut, will be the best remedies. (IV.) When it is found that a young crop of fall wheat has been injured by the Hessian Fly, it is a good plan to apply the following spring a light dressing of some quick-acting special fertilizer.

The worst attacks by the Hessian Fly which have come under my notice this year have been in Prince Edward Island, and in the province of Ontario in the counties lying between Lake Ontario and Lake Huron. References to injuries by the Hessian Fly in the province of Manitoba were, as far as I could learn, erroneous, although this insect may at some time be expected to appear there also as an injurious species, for Prof. Otto Lugger finds it in Minnesota, in the Red River valley, where the conditions are similar to those of a large part of Manitoba, he says: "A large area is infested, especially the western part of Central Minnesota from Brown's Valley to the Mississippi River at St. Cloud. Further north and south the fly is found in lesser numbers, and only a few occur in the northern part of the Red River valley and along the Iowa State line. The damages in some places amounted to more than 25 per cent, in others to 5 per cent and less, but on an average our farmers lost from 5 to 10 per cent of their entire wheat crop." (Otto Lugger, *2nd Ann. Rpt.*, 1896.)

"Pleasant Grove, P.E.I., Sept. 9:—I send you two samples of infested straw, one from my own field and the other from my neighbour's, which fell down badly this year. There were only a few plants in my field which fell down this season. Since learning from your reports the history of these pests, I have grown good crops of wheat by sowing late and dressing the land with a coat of good manure. My crop this year is a good one, the straw is as yellow as gold and almost free from rust."—[Edward Wyatt.]

Mr. Wyatt kindly supplied me with several samples of infested wheat straws and also with many stems of grasses from a field which had been badly attacked by Hessian Fly. Among these it may be mentioned that two stems of Timothy grass (*Phleum pratense*, L.) contained undoubted puparia of the Hessian fly. This was a matter of considerable interest to me because from the statement made in Miss Ormerod's well-known *Manual of Injurious Insects* I have frequently endeavoured to find traces of the Hessian Fly in any of the wild grasses. The statement referred to (quoted from Dr. C. Lindemann, of Moscow, Russia) is as follows: "Two kinds of wild grasses subject to the attacks of Hessian Fly are Timothy grass and Couch grass. In 1887 the first named of these was found to be severely attacked in the Russian Government of Tambov, and Couch grass was attacked in the Government of Tambov and also of Woronetz; Couch grass was so severely attacked that in whole districts covered with this grass, it was destroyed." This statement is of interest because of its possible bearing on the question of the original home of the Hessian Fly. A species which attacked a wild grass so severely as

above mentioned would appear to be much more at home than where it attacked only a cultivated plant of exotic origin, such as wheat is in America.

From Mr. Wyatt's observations it would appear as though at least two or three different kinds of insects were attacking the wheat on Prince Edward Island.

Samples of Hessian fly were received from several other places on Prince Edward Island. One sample, which came through Mr. F. G. Nash, of the Charlottetown *Patriot*, and was taken from a field of wheat on the farm of Mr. Joseph Wise, was found to be very much parasitized by minute hymenopterous enemies.

THE WHEAT-STEM MAGGOT (*Meromyza Americana*, Fitch).—The presence of this insect in a crop of wheat is very easily detected in the summer time when the ears of attacked stems turn white before the rest of the crop ripens. This injury is known under various names in different parts of Canada, such as "white heads," "bald heads," "silver top." If these stems are examined, it will be found that the base of the topmost joint of the stem has been gnawed away by a slender glassy green maggot a quarter of an inch in length, pointed at one end and having black horny mouth parts; to this injury is due the dying of the heads before the grain ripens. In addition to the above, there is another attack on the wheat crop by the same insect, similar to that of the autumn brood of the Hessian Fly, in the root shoots of fall wheat; it also occurs in many kinds of wild grasses. There is besides an intermediate brood which feeds upon grasses and volunteer wheat and barley. The severity of the summer attack in wheat fields seems to vary very much in different years, according to the season. Occasionally the injured stems will constitute as much as 5 per cent of the crop. This was the case nine years ago in Ontario. When full-fed the larva of the brood which attacks the stems works its way up to the upper portion of the sheath and turns to a slightly flattened and very transparent green puparium, from which the fly emerges at the end of July and during August.

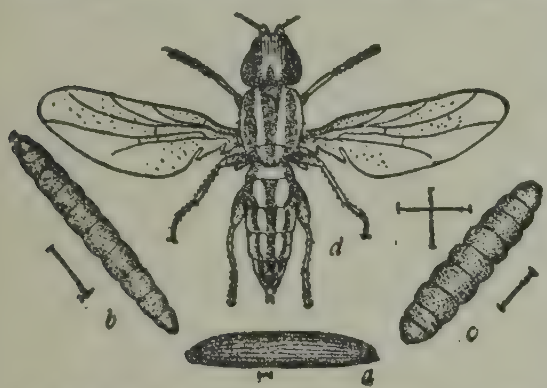

Fig. 4.—The Wheat-stem Maggot: *a*, egg; *b*, maggot; *c*, pupa; *d*, fly—all enlarged. (Figure by Prof. H. Garman.)

The perfect insects, of which three distinct broods appear at Ottawa, viz., in the beginning of June, at the end of July, and at the end of September, are active, greenish-yellow flies, one-fifth of an inch in length, with shining green eyes and three dark stripes extending down the back (Fig. 4*d*). The hind thighs are much thickened, and when the fly is at rest the fore part of the body is raised. Very soon after emerging, the sexes pair and the eggs for the next brood are laid. These are snow-white, spindle-shaped, beautifully marked with narrow longitudinal lines, some of which run into each other. These lines are connected with each other by much slighter transverse lines. When looked for, the eggs are easily seen on the upper sides of the leaves, owing to their white colour, although, of course, they are comparatively minute, about $\frac{1}{40}$ of an inch (Fig. 4*a*).

The Wheat-stem Maggot, which, owing to its attack at the roots of wheat, is also called the Wheat-bulb Worm, occurs all through Eastern Canada, and although the adult flies are enormously abundant in meadows and prairies all the way from northern Quebec through the Lake Superior region, Manitoba and the North-west Territories, its attacks in grain fields have not been complained of under its own name until last season, when it was discovered by Mr. George Greig, the Manitoba agent of the *Farmer's Advocate*, that this insect is the cause of a considerable part, at any rate, of the injury to wheat in Manitoba which has of late years attracted so much attention under the name of "dead heads". In company with Mr. Greig, I was able to confirm this observation at several points in the province of Manitoba during the past summer. There were, however, several stems of wheat which showed the "dead heads", in which we could find no injury by the Wheat-stem Maggot. Some of these stems in one locality had been bruised, without being broken down, by hail. In no case could I find any trace of fungus attack. From the observation of Prof. Otto Lugger, it appears that "dead

heads" are also caused by the attacks of a Frit-fly (*Oscinis soror*, Macq.), the maggot of which is described as boring inside the lower portion of the culm. Throughout the province, although many enquiries were made, there were far fewer complaints of "dead heads" this season than last.

Mr. Peter Elder, of Blyth, near Rounthwaite, Man., showed me all through one of his large fields where last year a serious loss occurred from "dead heads," and not a trace was this year to be seem. Mr. A. C. Hawkins, of Swan Lake, Man., cited in my last report, writes: "Sept. 10.—According to promise, I endeavoured to procure specimens of the larva causing damage to wheat, known as 'dead heads'; but the only sign of insect work I found was an empty cocoon a little over $\frac{1}{8}$ of an inch long and yellowish-white in colour. (Undoubtedly of Wheat-stem Maggot.—J.F.) There were very few 'dead heads' in the crop." Mr. George C. Mannix, of Stonewall, who suffered last year, also writes: "I am happy to say there are no 'white heads' in the wheat this year."

References to "dead heads" made by Manitoban farmers all speak of this injury as being a new one, and, judging from the behaviour of the Wheat-stem Maggot in Ontario, and in Manitoba during the past season, I think it may be confidently hoped that this is not going to be a constant source of loss to the wheat farmers of the West. The insect feeds naturally in the grasses of the prairies, to which under ordinary circumstances it will chiefly resort, and I believe that its attacks upon wheat occurring so occasionally are due to climatic conditions which are not likely to occur every year. Moreover, wherever I have collected the mature flies by sweeping the prairie grasses with a collecting net, I have invariably found large numbers of its special parasitic fly, *Cœlinius meromyzæ*, Forbes. Notwithstanding the above, however, Prof. Otto Lugger, of Minnesota, who has also studied it in his State, where in 1895, 1896 and 1897 it was common from the Red River valley to the central part of East Minnesota, says that it threatens to become in the future a serious enemy of their crops of small grain. "In some parts of the State the late sown rye, which had made but little growth during the autumn and which grew slowly in spring, was greatly damaged, in some cases to the extent of one-tenth of the crop. Wheat did not entirely escape, and the plants infested by the insects showed their presence by their small size and general weakly appearance."

Remedies.—(I.) Should the attack of the Wheat-stem Maggot increase seriously and its presence be shown by the "dead heads," certainly much may be done towards reducing the numbers of the next brood by sowing a drill or two of wheat or barley in close proximity to the infested fields. This should be sown as soon as the injury is detected, so that the young plants may be up in time to attract the females for egg laying. After the middle of August these strips should be fed off by sheep or ploughed down. All stubble should be harrowed as soon as possible after the crop is carried, so as to start a volunteer crop, which should be ploughed down early in September. The late sowing of fall wheat, where this crop is grown, could not profitably be delayed long enough to escape the egg-laying period of the last brood.

(II.) The application of special fertilizers as a top dressing when young wheat is known to be attacked, will help injured plants to throw out new stools and overcome to some measure the effects of the attack.

THE AMERICAN FRIT-FLY (*Oscinis carbonaria*, Loew.).—The maggot of this enemy of the wheat is only $\frac{1}{12}$ of an inch in length and yellowish-white in colour. These maggots may be found in autumn destroying the bases of the stems of several kinds of grasses and of fall wheat. They also occur in spring wheat and grasses in June, attacking the young root-shoots close to the ground and either destroying or seriously weakening them. Some eight or ten years ago the American Frit-fly was the cause of extensive and widespread loss in Canadian wheat fields, but since that time hardly a mention of it has been made by correspondents; nor have its attacks been noticed

Fig. 5.—The American Frit-fly—enlarged.

on grain crops at Ottawa. In 1890 this insect was very injurious in Kentucky, and was well worked up by Prof. H. Garman, who published an excellent bulletin thereon under the name *O. variabilis*, Loew. (*Bull. 30, Ky. Ag. Ex. Sn.*) Prof. Garman writes: "I think it very likely that the *Oscinis carbonaria* of Coquillett's notes is the *O. variabilis* observed by you and me in 1890. I never felt quite satisfied with the determination. The flies were abundant here at that time, but have not been seen since." The life history in many particulars agrees with those of the Wheat-stem Maggot and the Hessian Fly, but there is still some uncertainty as to the range of variation in its habits. Such part of the life history as had been worked out up to 1890 is given in the Annual Report of the Experimental Farms for that year. In Prof. Lugger's Second Report, 1896, what is apparently an allied species is described with the important difference of habit that the larva bores inside the stems of wheat causing them to break down, and before that producing the appearance known as "dead heads." This attack was not observed at Ottawa when the American Frit-fly was so abundant, but the family to which this insect belongs is one which is remarkable for the diversity which is found in the feeding habits of the larvæ.

Fig. 6.—The American Frit-fly: pupa-case—enlarged.

Remedies.—The remedies for this insect are the same as those for the Hessian Fly, viz., the late sowing of fall wheat, the harrowing of stubble (or in the West the burning over or ploughing down of stubble), and the application of special fertilizers in spring.

As some of my correspondents have had difficulty in distinguishing between the American Frit-fly, the Hessian Fly and the root-infesting larvæ of the Wheat-stem Maggot, I quote from my annual report of 1890 the chief differences:—

"The three insects are easily distinguishable in all their stages. In the larval or maggot stages, in which they do all their injury to crops, they may be known by the following characters:—

1. *The American Frit-fly*:—Maggot long and slender, yellowish-white with two small but distinct black hook-like jaws. The last division of the body bears two little knob-like processes. Length when full grown $\frac{1}{12}$ of an inch.

2. *The Wheat-stem Maggot*:—This resembles the last named in shape and structure, but is conspicuously different by reason of its clear glassy green colour, and also by its much larger size, $\frac{1}{4}$ of an inch when full grown.

3. *The Hessian Fly*:—This is proportionately much broader than the other two, of a clearer white than the American Frit-fly maggot and nearly always shows a green stripe down the centre. Instead of the two hook-like black jaws which are present in the two previously mentioned maggots, the Hessian Fly larva has a horny forked organ sometimes called the 'breast-bone.' Length when full-grown, $\frac{1}{8}$ of an inch.

"In the chrysalis stages the differences are equally marked:—

1. *The American Frit-fly.*—The pupa-case is shaped as shown above (Fig. 6) and is of a pale chestnut brown.

2. *The Wheat-stem Maggot.*—Changes to a pale translucent pale green pupa-case (Fig. 4*c*).

3. *The Hessian Fly.*—The pupa-cases of this insect are of a deep rich brown, like small flax seeds (Figs. 2 and 3), and it is in this stage that farmers will most easily recognize the Hessian Fly.

"The perfect insects are very unlike. The American Frit-fly is shown at Fig. 5 very much enlarged. The colours are black and yellowish-white. It is a very small insect, large specimens being only $\frac{1}{15}$ of an inch in length. They are extremely active and hard to observe. The fly of the Wheat-stem Maggot is a slender yellowish-green fly $\frac{1}{5}$ of an inch in length, with three dark lines down the back, eyes golden green (Fig. 4*d*). The Hessian Fly is a delicate dusky gnat, well shown in Miss Ormerod's excellent figure where it is represented magnified and enlarged (Fig. 1)."

The JOINT-WORMS (*Isosoma*). — There are probably more species than one belonging to the genus *Isosoma* which attack the wheat plant in Canada. These injuries appear to be of rare occurrence, but have sometimes been serious in certain localities. In 1895 specimens of fall wheat infested by a Joint-worm were received from Meaford, Ont., on the Georgian Bay. This attack, although amounting to 5 per cent of the entire crop in the year named, has not occurred since. The galls made by this insect were almost entirely in the sheaths of the leaves and not in the tissues of the stems. Last year infested straws containing joint-worms were received from Mr. Wm. Welsh, of Verdun (Bruce Co., Ont.). Although from a district less than 100 miles from Meaford, and further, strange to say, although it is the only other report of noticeable injury by joint-worms to wheat which has been reported to me for some years, it would appear from the different nature of the galls which are entirely in the tissues of the stems and not in the leaf sheaths, that this occurrence may be of a different species of joint-worm. Mr. Welsh writes at the end of the season of 1898: "The joint-worm, which was so abundant last year has done little injury this season. I made many examinations for the insect but could find very little damage. In the grain after threshing there were very few of the hard broken pieces such as I sent you last spring. This disappearance, I think, may have been due to the very wet spring and early summer we had." Unfortunately, the exact identity of the Meaford specimens could not be determined; but, through the kind assistance of Mr. Welsh, who has sent several parcels of infested straw from Verdun, large numbers of the flies have been bred. These were chiefly from stubble collected in the spring, April 15, in a clover field, where they had lain on the ground from the time the fall wheat was cut the year before. Specimens of stubble from the same field, but collected in November, 1897, and broken joints from the stems taken from the threshed wheat which had been kept in breeding jars through the winter, failed to produce more than two or three specimens of the perfect insect, whereas the stubble which was left in the field all through the winter gave hundreds of specimens of the gall-former, all the females of which were winged like the males. Besides these there were two kinds of hymenopterous parasites. Specimens of all of these were submitted to Dr. Howard, so as to get an authoritative decision on the species.

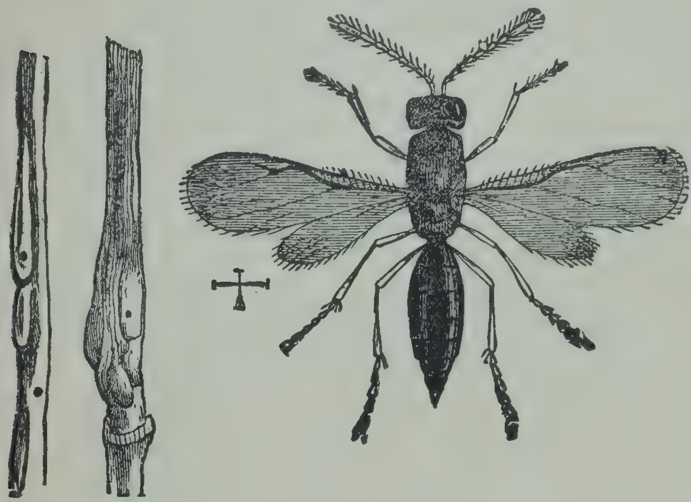

Fig. 7.—The Joint-worm: galls on wheat stems—natural size; fly—enlarged.

Dr. Howard reports as follows: "The species is undoubtedly *Isosoma tritici*, Fitch (*nec* Riley). If you will consult my Bulletin 2, Technical Series, page 17, on Phytophagic Eurytominæ, you will find that this is the species called *I. hordei* by Walsh. I think Walsh's specimens also came from Canada. Among the material sent by you after it was mounted I found two species of parasites, viz., *Homoporus chalcidiphagus*, Walsh, and *Eupelmus epicaste*, Walker."

There are so many discrepancies between the descriptions of the galls and their modes of occurrence and with regard to important points in the life histories of the joint-worms that with a view to working out the identity of the different species I shall be pleased to receive specimens from anyone who may find his crops attacked by joint-worms. The galls will somewhat resemble the figure (Fig.7), given herewith or may be as in the case of the Verdun specimens mentioned above, merely hardened and somewhat curved portion in the straws of wheat, barley or rye.

Remedies.—There is only one brood of the joint-worms, and as they pass the winter in the straw, for the most part so near to the ground that a large proportion of the larvæ occur in the stubble left on the fields, they can be largely reduced in numbers by burning over the stubble or by ploughing it down deeply. The broken off hardened

pieces of straw observed in threshing and cleaning should be carefully gathered and burnt. Sometimes, as stated above, there are no galls formed, the presence of the larvæ causing merely slight swellings and the hard thickened condition of the straw. These portions break off in threshing and many are carried through with the grain. The threshed straw should be examined, and if the larvæ are found therein it should be destroyed either by feeding or some other consumption before the ensuing spring.

THE GRAIN APHIS (*Siphonophora avenæ*, Fab.).—The green, yellow, red or blackish plant-lice which are frequently seen upon all the small grains are well known by most farmers. These insects are found in some numbers every year and in occasional seasons increase to such an extent as to cause widespread alarm. Notwithstanding this general increase in numbers, it cannot be said that their attacks have ever materially decreased the wheat crop of the year, for they are invariably accompanied by various parasites which gradually increase in numbers and feed upon the plant-lice until most of them are destroyed. The two most numerous of these parasitic species in Canada are *Aphidius granariaphis*, Cook, and *A. obscuripes.* In addition to these there are always many of the leech-like larvæ of the Breeze-flies, *Syrphidæ*, which crawl about among the colonies of plant-lice and every day destroy large numbers, as they feed entirely upon plant-lice.

The Grain Aphis multiplies with great rapidity and the insects may be found of all sizes and colours all on the plants at the same time. The females bring forth living young continuously and these young lice are in a few days full-grown and themselves begin to propagate in the same way. There are no practical artificial remedies which can be applied on a large scale to fields of grain.

The WHEAT-STEM SAWFLY (*Cephus pygmæus*, L.), treated of at length in my report for 1896, has only been mentioned by one correspondent.

"Buffalo Lake, Moose Jaw, Assa., March 3, 1898.—I send a few heads of wheat such as appeared in one of my fields last year. This field was hailed out in 1896 and having been sown on summer-fallow the straw was burnt as it stood in the spring of 1897. A week or two previous to cutting, I noticed a great many straws and heads like those I enclose scattered loose among the grain, fully 5 per cent of the crop. You will notice that the heads were well developed at the time. Is this the work of the Wheat-stem Sawfly?"—[George S. Tuxford.]

It may be hoped, I believe, that the attacks of this insect upon grain will be only of an intermittent nature, for where the insect was abundant at Souris, in Southern Manitoba, no appearance of it has since occurred. Mr. J. Wenman writes me again this year that he has not heard of nor seen any trace of the insect since 1896. In company with Mr. Angus Mackay, I examined carefully the wheat fields around Indian Head, where I had collected specimens in 1895 and at the date the mature insects should have been flying, but although the standing grain was swept with a collecting net at all times of the day and in several different localities not a single fly could be found.

CUTWORMS in grain.—Occasionally considerable harm is done in grain crops by cutworms. There are several grass-feeding species in this large family which are liable to attack cereal crops. The injuries to Indian corn are well known and can be prevented to a large measure, but when a field of the small grains is attacked the only recourse is to adopt some agricultural treatment founded on the known life-history of the depredator. The exact identity, then, of the species is of importance, so that the life-history, if recorded, may be used as a guide to escape loss. An instance of the value of such information is found in the following correspondence:—

"Carleton Place, Carleton Co., Ont., May 26.—We send a box containing some cutworms. They have destroyed two fields of our oats. What can be done to prevent them from destroying all our crop? Would spreading lime over the field kill them, and how long will it be until they have passed away, so that it will be safe to sow some other grain or to plant corn on the fields where they ate the crop off?"—[J. Yuill & Sons.]

Reply: "Your letter of the 26th inst. containing cutworms from your oat field came to hand, but the cutworms had eaten each other until only one shrivelled up bitten

specimen remained alive. Please send me some more, and if possible in a tin box with plenty of food. There are two kinds of these cutworms much alike, and I cannot, from the specimen I have, tell whether they are of one which matures early, or of the other which does not reach full-growth sometimes till July. In this case exact identification is very important before I can advise you what crop to sow on your land. Corn for ensilage may, I suppose, with you be sown as late as 12th or 14th June, turnips up to 20th June and rape or Hungarian grass up to 1st July. Spreading lime would have no effect whatever on these caterpillars."

"June 2.—We send you another sample of cutworms, as requested, and have cultivated the field again. We are now waiting your answer to know when we shall be safe to sow again. If it would be safe to sow oats soon, we should prefer that crop."—[J. Yuill & Sons.]

Reply: "I am in receipt of your letter of the 2nd inst. as well as the cutworms sent. These are the Glassy Cutworm, the caterpillar of the Devastating Dart Moth (*Hadena devastatrix*, Brace). I have waited a day or two before answering your letter so as to be able to say—what I now believe to be the case—that you can sow oats safely on your land. If you have any convenience for turning chickens or turkeys on to the field for a day before the oats are sown, they would doubtless destroy large numbers of the caterpillars or their chrysalids. I shall be very much obliged to you if you will let me hear from you later in the season what success you obtain from sowing oats on this land so late in the season. You will, I suppose, probably cut them for green feed.

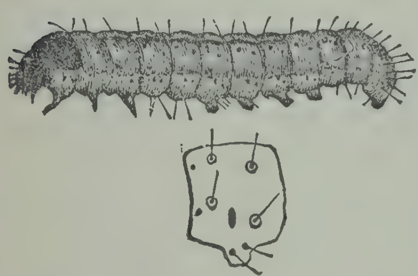

Fig. 8.—The Glassy Cutworm.

"The other cutworm referred to which resembles very much the Glassy Cutworm, but is whiter and has a redder head, is the caterpillar of the Amputating Brocade Moth (*Hadena arctica*, Bdv.), a species which also attacks the roots of grasses and grain. This caterpillar does not reach full-growth usually till after the middle of June."

"Dec. 28.—We broke up about 30 acres of sod land. The autumn before being so dry, we did not get it ploughed. Ten acres of this were sown in peas, the remainder was sown in oats. There were no cutworms in the peas, but all the oats that were sown on sod were eaten more or less. About ten acres was eaten clean out. Following your advice, we turned the turkeys and chickens on the fields and have no doubt but they would have cleaned the cutworms, had it not been that the crows took so many of the young chickens that we were obliged to bring them home.

Fig. 9.—The Glassy Cutworm Moth.

"On the eighth of June we sowed with peas and oats, about 3 parts oats to 1 of peas. This crop was not injured by the cutworms. We had a very heavy crop which we cut a little green and are using for fodder."—[J. Yuill & Sons.]

THE ROCKY MOUNTAIN LOCUST
(*Caloptenus spretus*, Uhler).

It is now some years since any serious injury has been reported in Canada by the Rocky Mountain Locust, although from time to time mention was made in newspapers of the temporary spread up into Southern Manitoba, of small swarms from parts of the Turtle Mountains in North Dakota, where the species breeds probably every year. Such was the case in the autumn of 1897, and the females were seen laying their eggs on the farm of Mr. John Scott, near Deloraine. From these eggs enough young locusts hatched in the spring of 1898 to cause considerable loss in grain crops. The season was

exceptionally dry, and there was no green thing in the country for the young locusts to eat except the settlers' grain crops. The injury of this attack was augmented by the fact that from lack of spring rains a large proportion of the seed grain had failed to germinate, and, consequently, all crops were very thin on the ground.

I visited the infested localities, in company with Mr. Hugh McKellar, Chief Clerk of the Manitoba Department of Agriculture, and drove with him to all the places at which it was known that locusts had been observed. None of the farmers, with the exception of Mr. John Scott, remembered seeing locusts in injurious numbers before. Considerable damage was done on the farms of Mr. J. H. Urie, Messrs. Leonard and Robert Sawyer, Mr. John Scott and Mr. D. S. McLeod. The farm of the last named is at Lennox, the most westerly point visited ; this is just round the spur of the Turtle Mountains from Deloraine. I was unable to visit some farms said to be infested near Boissevain, but through the kindness of Mr. Arthur S. Barton, of the Dingle, Boissevain, and Mr. Charles A. Sankey, of Boissevain, I was kept well informed as to the visitation and provided with specimens for examination. On my return to Ottawa and at the time when the farmers would have finished their harvesting and be at liberty to plough their land, I prepared the following article upon this important subject, and so that it might reach as many farmers as possible, sent it to the *Farmer's Advocate*, which has a very large circulation and which published it both in its Manitoba and its general edition. Similar articles were also published in the *Weekly Star* of Montreal and two or three in the *Winnipeg Free Press.*

THE ROCKY MOUNTAIN LOCUST.

During last June notices appeared in the newspapers that injury was being done by grasshoppers or locusts in southern Manitoba. These reports naturally caused much anxiety among the old settlers who had been in the Prairie Province at the time of the serious locust depredations during 1868, 1870, 1872, and 1874.

Fig. 10.—The Rocky Mountain Locust.

By instruction of the Honourable Sydney Fisher, and at the request of the Hon. Thomas Greenway, I visited the localities reported to be infested in the beginning of July and again in the middle of August. The reports of injuries to growing crops were found to be correct, and the locust which was doing the injury was, as in the former invasions referred to, the Hateful or Rocky Mountain Locust (*Caloptenus spretus*, Uhler).

The exact identification of the species was in this case a matter of no little importance, for it is well known that, although there are many kinds of locusts in the west, none of them are to be feared as crop destroyers to anything like the same extent as the above named, which has exceptional powers of flight and is gregarious in its habits. As is usually the case in such matters, when conviction on this point involved a good deal of extra labour, some farmers were slow to believe that such an ordinary-looking insect could be so serious an enemy as was claimed by those who recognized in the grasshopper of this year their old enemy of the early seventies, and doubts were being cast on the correctness of the identification. This question was at once decided upon catching a few specimens near Deloraine. To one who has studied these insects it is, of course, just as easy to distinguish the Rocky Mountain Locust from its near allies as it is for a farmer to tell wheat from rye, barley or oats.

A good use of this special knowledge was made by Mr. John Scott, who has lived a few miles south of Deloraine for many years. He noticed a swarm of the locusts to alight on his farm last autumn, and this spring warned his neighbours to be on their guard and take some steps to protect their crops, similar to those he himself adopted. As soon as the grasshoppers hatched he spread rows of dry straw across the field where they were most numerous ; the young hoppers gathered into these at night in large

numbers and were destroyed by the straw being set on fire after nightfall. This was repeated four nights running, and myriads were thus killed before they had spread far from their hatching grounds or had done any appreciable harm. Had Mr. Scott's neighbours followed his advice and example, there is no doubt that the loss would have been much less than was the case in that district last summer.

The area over which the Rocky Mountain Locust occurred in Manitoba this year was a narrow strip only a few miles in width, lying to the south of Deloraine and Boissevain, and running along the northern slope of the Turtle Mountains. It is probable that this locust breeds regularly every year in parts of the Turtle Mountains, but it is many years since it spread from these breeding grounds north into Manitoba. It has, however, shown only too well in previous years that it is able to breed and multiply on our prairie lands when once established there. As, therefore, judging from the experience of the last twenty years, it is unlikely that fresh swarms will for some time again spread from their permanent breeding grounds, it is of the utmost importance that everybody in the infested region should do everything possible to help in exterminating this formidable foe. This is particularly the case in the present instance, because if all will work together complete extermination should be a matter of comparative ease. The life habits of the insect are well understood, and the experience of farmers living in regions where it occurs much oftener than with us, shows that by making a very small change in the ordinary methods of working their farms, and at no very large extra expense, this dire enemy can be practically wiped out, even where eggs have been laid in enormous numbers.

WHAT TO DO.

It is conceded by all that the best remedy is the ploughing down of the eggs so deep—five or six inches is sufficient—that when the young locusts hatch in spring they may not be able to work their way up to the surface. The important things, then, for Manitoban farmers to do now are to discover where eggs have been laid on their farms and to see to it that every rod of this land is ploughed either this autumn or next spring before the young locusts emerge and move off into the crops.

WHERE THE EGGS ARE LAID.

The places where the mother insects lay their eggs can be discovered only by seeing them at work, or by examining the soil carefully for the egg-pods. The time required for boring the hole and laying the complement of eggs is three or four hours. The appearance of the insect itself, the pods and the separate eggs are well shown of natural size in Dr. Riley's excellent figure herewith.

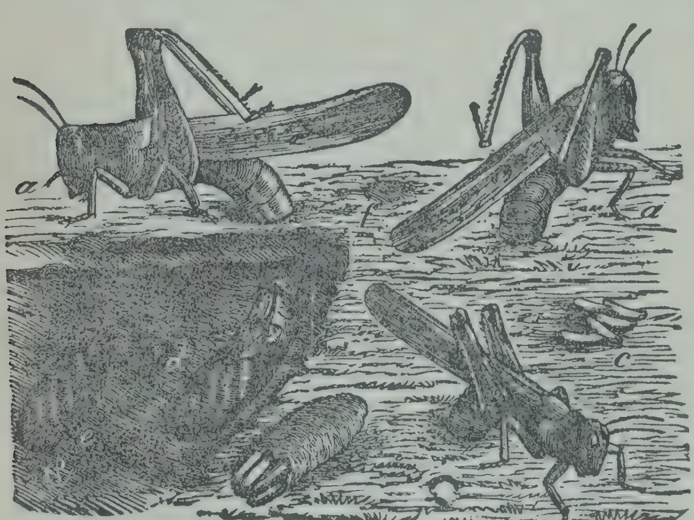

Fig. 11.—Locusts laying their eggs.

The female locust lays her eggs in the ground, about an inch beneath the surface, in small pod-like masses, as shown in the figure. The egg-pod consists of a coating of a waterproof mucous material, which is deposited at the same time as the eggs. There are in each pod about 30 eggs, and each female lays about three pods during the autumn. There is only one brood in a season, the winter being passed in the egg. When the young locusts hatch, they emerge through the upper end of the egg-pod. In Manitoba last season the young hoppers were noticed about the 1st of June, but they probably hatched early in May, because it takes seven or eight weeks for the insects to attain full growth, and winged hoppers were abundant by July 8th at Deloraine.

The eggs are laid for the most part in stubble fields. They are very seldom laid in thick sod or in loose, newly-ploughed earth. In the first case it is difficult for the female to form the chamber in which she lays her eggs, owing to the numerous roots of the grasses, and in the second case the burrows could only be made with great difficulty in the dry, powdery earth. All observers report that eggs are rarely laid in newly-ploughed and well-harrowed land.

The late Dr. C. V. Riley wrote: "The egg may be laid in almost any kind of soil, but by preference they are laid in bare sandy places, especially on high dry ground, which is tolerably compact and not loose. . . . Newly ploughed land is not liked, it presents too loose a surface; but new breaking is often filled with eggs." (This is doubtless owing to the firm surface of the sod before backsetting.) "Sandy soil that is compact, especially when having a south or east exposure, is much chosen; but in loose and shifting sand the eggs would perish."

Prof. Otto Lugger, State Entomologist of Minnesota, writing in July, 1889, after examining a district which had been devastated, says as to the places chosen for egg-laying: "A close inspection soon revealed the fact that fields with last year's stubble contained large numbers of eggs, whilst stubble land of the previous year and older contained none or but very few. . . . There were some eggs in denuded spots of timothy fields; . . . where the timothy plants covered the ground entirely no eggs could be detected; a similar observation was made in pastures; if well sodded, no eggs; if bare of vegetation, a few could be detected. No eggs could be found in the native prairie land, and but a few along roads and the elevated beds of railroads."

In the Special Bulletin issued on this subject by the North Dakota Agricultural Experiment Station in 1891, it is stated: "As the eggs are never laid in thick sod nor in loosely ploughed earth, it will be seen that the ploughing need not extend to any land except the stubble fields."

From the foregoing extracts by three of the leading authorities on the subject, it is evident that if farmers will attend carefully to their stubble lands, where by far the greatest proportion of the eggs are laid, there is every hope that next year there may be no trouble from locusts; but, at the same time, it must be borne in mind that unless all help, there were certainly sufficient locusts this year in the district I visited, for the young to commit serious depredations next year, and to spread over a much wider area in the Province.

Remedies.

Ploughing.—The remedy above all others, as stated above, which has given satisfactory results is the ploughing down of the eggs, and although harrowing has been recommended by some, it cannot be relied on. Knowing the importance of giving definite advice to the farmers of southern Manitoba, I corresponded with the State Entomologists of Minnesota and North Dakota, both of whom have had extensive experience in fighting the Rocky Mountain Locust. I submit herewith quotations from recent letters giving most valuable information:

"St. Anthony Park, Minn., August 23.—Ploughing from 4 to 4½ inches deep is the only true remedy. It is not necessary to plough during the fall, though best; if ploughed early in the spring the surface of the field will become quite compact by rain, even by the wind. None or but very few young locusts will reach the surface, and these will starve before reaching plants upon which to feed. Permit no stubble fields. They should all be ploughed, as in them most of the eggs will be deposited. A few acres of stubble land can and will breed enough locusts to endanger the crops of all the surrounding fields. In the past I have repeatedly tried the plan of harrowing in the autumn instead of ploughing, and have invariably failed, since sufficient numbers of locusts hatched to destroy the crop. In fact, the trouble near Perham was almost entirely caused by a party who insisted on harrowing the fields containing eggs instead of ploughing them. He harrowed thoroughly during the autumn, but in spring I found numerous eggs and egg-pods. At my request he harrowed again in spring (would not plough) and seeded with a drill. This field was the principal one in which numerous locusts hatched and from which they migrated to others."—[Prof. Otto Lugger.]

"Agricultural College, N. Dak., Aug. 30.—There is no question as to the efficacy of ploughing. Fields lying side by side on the same ridge of land that were visited by Rocky Mountain Locusts last fall showed this point very clearly. One of the fields was left unploughed, and from this small area probably 250 bushels of grasshoppers hatched out, while in the fields that were ploughed no trace of grasshoppers could be found except as they came from unploughed fields. The farmers in parts of this State find that early fall ploughing gives a much better yield of wheat than either late fall ploughing or spring ploughing, and, for this reason, as well as for the destruction of the locusts, we recommend that all fields in the infested localities be ploughed as early as possible.

"So far as ploughing simply to destroy the eggs of the locusts, there is no reason why this need be done in the fall any more than in the following spring. In fact, in the localities where grasshoppers appeared this year, fields that were ploughed immediately before seeding were as free as those ploughed shortly after harvest, though the ground in both cases was undoubtedly filled with eggs.

"Now, in regard to harrowing, there is no doubt that if the egg masses are brought to the surface and broken at this time of the year the vitality of the eggs will be destroyed. The only question connected with harrowing is how thoroughly the egg-masses will be broken up. Where soil is firm I have recommended harrowing, and then cross-harrowing, so as to disturb every portion of the surface. The disk harrow used for pulverizing sod about five or six weeks after breaking would probably do good work if the ground is too firm for the ordinary harrow. The heavy rains which usually come in August and September here, compact the soil so much that ordinary harrowing would probably fail to serve the purpose. Disking the fields immediately after harvest would leave the soil in such loose condition that the insects would probably avoid that locality for egg-laying."—[Prof. C. B. Waldron, Horticulturist, N. Dak., Agr. Exp. St.]

To secure the best results as far as the destruction of the locusts is concerned, fall ploughing is undoubtedly the most effective method; but, if from press of other work it is impossible to plough all land which was under crop this year, much good may be done by early spring ploughing before the insects hatch or before they are large enough to move from their hatching grounds to adjacent crops. Stubble land which it is intended to summer-fallow next year must be turned down, if possible, before the 1st of June, and at the latest by the middle of that month.

Other Remedies.—Should grasshoppers, notwithstanding all precautions, be found abundant, farmers may have recourse to burning by means of strips of straw, as was done by Mr. Scott this year, or to the use of hopper-dozers or tar pans, which are implements made of sheet-iron, containing some tar or coal oil in the bottom. A cheap and

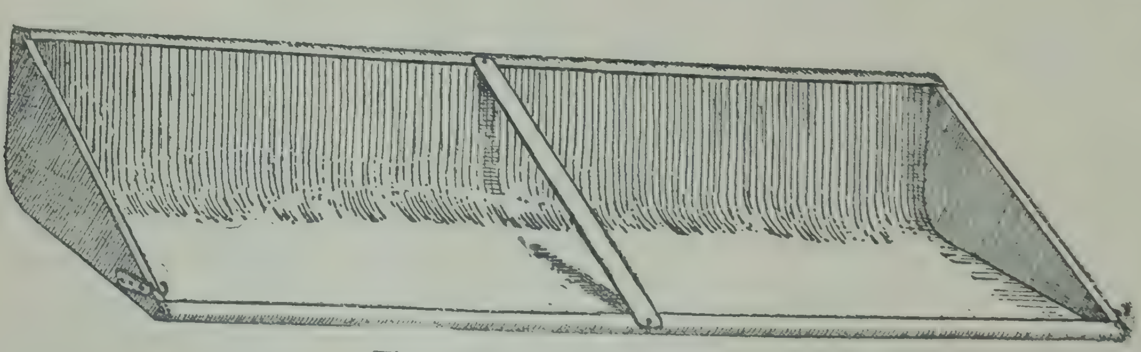

Fig. 12.—Grasshopper Dozer.

simple plan of one of these, costing from $1.50 to $2, was described many years ago by Prof. Riley. It consists of a strip of sheet-iron, 8 or 10 feet long, turned up 1 inch in front and 1 foot behind, with pieces soldered in at the ends (or made of wood) and hooks placed in front at both ends for the attachment of ropes. If to run on rough ground, it will be better to put runners, 1½ or 2 inches high, underneath Into this put a layer of coal tar ½ inch deep, or water and coal oil. The implement can be drawn by a boy at each end, or by a horse if preferred. (*Farmer's Advocate*, Winnipeg, 5 Oct., 1898.)

When examining the insects on Mr. Leonard Sawyer's farm a few miles south of Deloraine, on 8th July, Mr. Sawyer took me to a ravine where he had noticed a great many dead locusts lying among the grass. These were found to have been destroyed by the larvæ of a dipterous parasite. By digging down into the ground beneath the dead locusts, from 1 to 8 of these larvæ could be found, and the dead locusts were so numerous that they lay in every direction among the grass at a distance of only an inch or two from each other. Tachina flies and Flesh-flies were extremely abundant. Upon catching several of the locusts in both the pupal and the perfect stages, by far the larger proportion of them were found to contain the maggots of a fly, and in addition a great many of them were infested with locust mites, *Trombidium locustarum*, Riley. Although many of the maggots of the parasites had buried, none were found which had hardened into brown puparia. This was on 8th July, which may be considered the time when the first brood of maggots leaves the locusts. These latter were just passing the last moult and assuming the winged form. They were hanging in every direction from the stems of grasses, stretching their tissue-paper-like wings by means of their long hind legs. A box was filled with the parasitic maggots and from these were bred (22nd to 26th July), both at Ottawa and by Dr. Scudder, at Boston, large numbers of a flesh-fly which has been named through the kindness of Mr. D. W. Coquillett, of Washington, and pronounced to be "a species of *Sarcophaga* near *incerta*, Walker." They were bred from the living locusts, some of the larvæ being actually taken from insects caught flying in the field.

Dr. Scudder, who kindly furnished me with this identification, also named some other locusts taken at Deloraine among the specimens of *M. spretus*, as *Melanoplus atlanis*, Riley, *M. minor*, Scudd., *Camnula pellucida*, Scudd., and *Gomphocerus* sp.

Efforts were made during the past autumn to discover where eggs were laid and to secure specimens, but all to no avail. Many observers in all the infested localities tried to help me in this matter, but none could find that eggs had been laid. The weather was exceptionally dull and wet. Notwithstanding that no eggs could be found, farmers are earnestly urged to plough all the stubble land that is possible, and endeavour to do this before the middle of June, whether it is to be cropped or summer-fallowed. This matter is one of far too much importance for any one to run the risk of trusting to luck that all will be well, when so much is at stake. Although no eggs have been found, I observed the locusts copulating on 17th August, and large numbers of healthy females with their abdomens well filled with eggs.

I append extracts from letters referring to this outbreak in which most of the points of importance are brought forward :—

"Boissevain, July 9.—I received your letter respecting the locust invasion in southern Manitoba. I have made general inquiries and had extracts from your letter published in local papers. So far, no one has observed any parasitic destruction of the pests ; but that may have been from the fact that, soon after I reported to you, the colony which appeared close to the bush on two farms near here seemed to disperse in a northerly direction. Some were found three miles north of the point where they first appeared. Of course, in this scattered fashion no immediate or general destruction of crops has been observed, but the danger may be all the more serious for another year. I understand that extensive precautions are being taken to the south in the way of deep ploughing, &c."—[Charles A. Sankey.]

"Boissevain, August 14.—I have been unable to discover any number of dead locusts or any of the parasites you asked about. The swarm is now scattered over a distance of a five or six mile radius from the spot where they were first observed, in varying numbers ; we have them here in small quantities. I found one farm, near the bush, where small patches of the wheat heads appeared to have been stripped of the grains, and I discovered a few locusts and a number of several species of ordinary grass-hoppers in the grass surrounding the field. I hope you will discover from your investigations that the danger for next year is, after all, not so great as we fear, but I do trust that if there is any danger you will not minimise it in the least, as farmers are only too ready to put off the thought of an evil day, especially if they can avoid

thereby any present inconvenience or expense. There are a number, however, who are only waiting for your report to take energetic action, should you consider it necessary."—[Arthur S. Barton.]

"Boissevain, September 10.—I have not yet found any eggs of locusts. They are still pairing, and great numbers can be found on the lee side of the wheat stooks. Is there any distinguishing mark on the ground where they lay their eggs?"—[Charles A. Sankey.]

"Deloraine, September 14.—I met Mr. D. Steedsman to-day. He has his man ploughing the ground you advised him to, and the man reported that he had not seen a single grasshopper. Yesterday, Mr. Steedsman himself went with the plough all round the field and did not see a single grasshopper nor any trace of eggs. Per contra I have noticed several hoppers six miles north of Deloraine. There is one point which it may be of importance to mention: during the two weeks preceding Friday, 9th September, we had very unusual weather—cloudy, heavy fogs by night, occasional heavy showers of rain, one especially so on Friday, 2nd September, when for two hours we had a perfect deluge. On Thursday, 8th September, we had a sharp frost, since which the weather has cleared, but to-day (14th September) is again cloudy and threatening rain."—[Dr. Robert S. Thornton.]

"Boissevain, September 24.—"I have not been able to discover any locust eggs as yet, and I have delayed writing in the hope of finding some. There are locusts on nearly every stook of grain. They are still mating, but appear very sluggish, frequently being lifted on to the stack on the sheaf and not attempting to move; this is principally in cloudy weather. I have scraped and dug, and examined (and so have my friends and neighbours), but so far we have not discovered a single egg. Can you tell me, if not too late, if there is any indication or mark left on the surface of the ground that would guide one in looking for the eggs?

"I saw a pretty sight last Friday; a large flock of Black-headed Terns or gulls came swooping down the field; dividing at the leeward side, they ranged the rows of stooks to the other side of the field; returning with the wind in a body, they again and again quartered the field. I was near enough to see them picking the locusts off the stooks as they passed. I came to the conclusion that it was not their first experience, and it would be interesting to learn if their absence this summer was due to locusts further south (in Minnesota), or whether their usual breeding place at Whitewater Lake was too dry for them. In other years we have a constant procession of them backwards and forwards from the lake to the bush, and constantly they follow the plough, picking grubs and larvæ out of the freshly turned furrows."—[Arthur S. Barton.]

"Boissevain, October 22.—I have made a close search for eggs of locusts, but so far with no result. Mr. Barton has also been unsuccessful, though it seems almost incredible to think that none have been laid; apparently a disaster in the shape of a severe snow-storm and frost has destroyed them. I do not think more than one supply of eggs can have been laid."—[Charles A. Sankey.]

"Deloraine, November 14.—With regard to grasshopper eggs: I have not written to you sooner because I had no information to give you. I have scraped and looked on our wheat stubble and on my neighbours' fields and have seen but one female loaded with eggs and no eggs in the ground. I heard of some being found two miles north-east of here and I went there to get some, but I could not find any. Mr. David Steedsman said that they had all moved north from his place and he did not think that there were any eggs laid on his land. Mr. Leonard Sawyer says he saw numbers of small grasshoppers full of eggs. I caught lots of them, and a good many had those worms in them which you showed me when you were here. I do not think many eggs have been laid here, where we had them thickest last year. The grasshoppers seem to have moved north and east and cover more territory than they did last year. While some farmers have ploughed a good deal of land, the fall has been so backward and the harvest prolonged that people have, on the whole, done very little work. I believe we all intended to follow your instructions as much as possible, but now we are frozen up. I heard of eggs being found 8 miles north of Deloraine, through reading your description of them in the *Weekly Star*.

I may find some yet, and if I do will forward them to you without delay. I am very much afraid the province may have more hoppers next year than most people have any idea of. I know that Mr. C. A. Young was trying to get information to send you, but he has nothing definite, so has not written lately."—[John Scott.]

Another outbreak of locusts occurred in the Nicola Valley in British Columbia. This was brought to my notice by Mr. Hewitt Bostock, M.P., who also forwarded specimens for examination.

Reports were also received from Mr. Pooley and Mr. Sidney J. Solomon as follows :—

" Nicola Lake, B.C., September 7.—Yours received *re* grasshoppers. I am sending by this mail some grasshoppers and their eggs, which I hope will be of some use to you in determining the species. The injury done by the hoppers was principally to the ranges and bunch grass pasture fields : also considerable injury to the oats, by their eating off the small stem which connects the grain with straw, and consequently all the oats were lodged on the ground. Injury to wheat, not any ; peas, scarcely perceptible. This is the second time the grasshoppers have appeared in our valley. The first time (which was in 1890) they made complete havoc, and unless something happens to destroy the eggs before hatching, it will be very little use putting in a crop next spring. The eggs are deposited on gravel and sandy hills (about an inch below the surface). Some of the eggs seem to have become dried, but the majority are quite fertile. Nearly all the grasshoppers have disappeared and a great many have died."—[William Pooley.]

" Nicola Lake, B.C., Dec. 31.—I could not grow enough feed to keep any quantity of hogs. The grasshoppers were very bad last summer and laid their eggs, so that we are expecting our crops will be all eaten by them next year. I shall put in very little wheat or oats, but principally peas and potatoes, as they do not bother these crops so much."—[Sidney J. Solomon.]

The early disappearance of the locusts mentioned by Mr. Pooley would indicate the probable presence of parasitic insects or some fungous disease. As it was important to know the exact identification of the species which were committing these depredations, the specimens received were forwarded to Dr. Scudder, who reported :—

" Cambridge, Mass., U.S., Dec. 2.—The mass of the material was a species of *Trimerotropis*, probably *cincta*, Thom. Out of the balance, I made out *Camnula pellucida*, Scudd., (many specimens), *Circotettix verruculatus*, Kirby, and *Melanoplus atlanis*, Riley."—[Dr. S. H. Scudder.]

The most numerous species was *Camnula pellucida*, which is sometimes extremely abundant and destructive in the West. This was the case between Kelowna and Vernon, B.C., in 1895.

In the case of this species, undoubtedly the use of hopper-dozers before the locusts have developed their wings would be attended with good results, and if, as is frequently the case with *Camnula pellucida*, the places chosen for egg laying are restricted areas, these may be treated early in June with much less trouble than later.

The poisoned bran remedy recommended for cutworms, page 190, has also been found very effective againts locusts in California.

When the eggs are found to be laid in cultivated ground, the ploughing of this in fall or spring would destroy all the young locusts contained in these eggs, and, if circumstances would permit of it, it might be tried in the Nicola Valley, by placing several small piles of the poisoned bran in the hatching grounds. This material seems to have a wonderful attraction for the locusts.

VEGETABLES AND ROOT CROPS

CUTWORMS.—The complaints of injury to garden vegetables and root crops have been this year fewer than usual, most references to the ordinary garden pests, such as cutworms, Tarnished Plant-bug, plant-lice, etc., being merely to mention their absence. In the province of Quebec, however, there was serious loss in some localities from cutworms, both in gardens and field crops. Very few specimens were submitted for examination, so only general instructions could be given. If correspondents would always send in specimens with their inquiries it would be far easier for the Entomologist and Botanist to give definite information and instructions, and he could thus be of more service to inquirers than is now sometimes the case when no specimens are forwarded.

"Quebec, June 14.—We are receiving from different parts of the province of Quebec letters informing us of the immense damage which is being done to vegetables by the plague of cutworms, against which our farmers do not appear to have any means of protecting themselves."—[S. Sylvestre, Secretary, Dept. Agr.]

"Causapscal, Rimouski Co., 30th May.—I am instructed by the Directors of the Agricultural Circle to send you the accompanying specimens of caterpillars which are occurring here in large numbers and eating up completely our peas, at first the stems and then even the seed pease in the earth. Farmers have been obliged to sow their fields of peas over again. Can you tell us where this pest comes from, how long it will continue to devastate our crops, what it will change to, and above all the best means of destroying it? If we are not able to check this plague, our crop will be a total failure." —[V. O. Morrissette.]

As specimens accompanied this inquiry it was seen at once that they were the so-called Black Army-worm (*Noctua fennica*, Tausch.) and had reached full-growth, so that the application of a remedy was not necessary. These caterpillars were also somewhat abundant in gardens at Ottawa, where they attacked every kind of vegetables, and also to some extent in clover fields. This insect is one which from time to time appears suddenly in large numbers, and then does a good deal of harm. In the last stage of its growth it is a voracious caterpillar which eats indiscriminately almost every kind of vegetation. Prof. Lugger, who treats of it under the name of the Erratic Army-worm, when recording an outbreak which occurred in the State of Minnesota, says that: "The caterpillars devoured every green thing upon the face of the ground. They preferred, however, such plants as were bitter, hence the foliage of cherries, willows, poplars and sumachs was the first to be eaten. After these nearly all others were devoured."

From my own observations of several occurrences of this insect at Ottawa I believe its natural food plants to be the Leguminosæ—cultivated peas and clover being particularly relished. The early maturing of the caterpillars (generally by the end of May or very early in June) frequently prevents the injuries of this insect from being as serious as they might be and actually often seem to be. In 1891 a three-acre field of peas upon the Central Experimental Farm was swept bare by an army of these caterpillars. The damage was stopped promptly by spraying a strip 50 feet wide ahead of the caterpillars with Paris green, one pound in 100 gallons of water, to which 4 pounds of soap had been added to make the solution adhere to the pease. This was applied with knapsack sprayers. Although the pea plants were eaten down entirely on three acres of the field mentioned, owing to the injury being done so early, the plants threw out fresh roots and gave actually a better crop than an equal area in the uninjured portion of the field.

Professor Lugger gives a similar instance in his Second Annual Report, as follows: "Nor was the actual damage done very great, as all the wild plants soon recovered and made a denser growth. The cereals which had been cut down to the very ground, assisted by the moist warm days which followed this invasion, not only recuperated but were in some cases even improved as they stooled better than those not cut by the worms."

The full-grown caterpillar is a handsome creature between $1\frac{1}{2}$ inches and $1\frac{3}{4}$ inches in length, cylindrical in shape, about $\frac{1}{10}$ of an inch in diameter. The general colour being velvety black, with white longitudinal stripes; head, red, black in front; legs, reddish. The dorsal area is more or less shaded with brick red; dorsal stripe of velvety black diamond-shaped marks; the lower edges of the dorsal area clearly defined by a black line, shaded beneath with an equally distinct white thread; sides dull-black, spotted with a few white points which hardly form a line. Spiracles black; substigmatal band distinct, white and undulating, bearing in the centre a very ragged black line washed with yellow, the upper margin dipping below each spiracle and then running up considerably higher than it towards the posterior margin of each segment. Ventral surface semi-translucent, dusky, mottled with white, the green contents of the body showing through the thin skin. When full-grown, about the end of May, the caterpillars burrow rather deeply into the ground and turn to dark brown chrysalids from which the moths emerge about a month or six weeks later. The perfect insect is for a cutworm moth handsome, and all the markings are sharply defined. It expands about $1\frac{1}{2}$ inches across the wings. The upper wings are dark blackish-brown, the orbicular and reniform spots white, bearing a few yellow or reddish scales and outlined with black. In the male the inner margin of the upper wings is yellowish brown, by which this sex can be recognized at once. The lower wings are gray, darker at the margins. There is in Professor Lugger's Second Report a beautiful plate by L. M. Hart, showing the caterpillars, the chrysalis and the perfect moths.

Remedies.—When the Black Army-worm attacks field crops, remedial measures must be taken with due regard to the nature and condition of the crop to be protected. In all instances which I have seen when the caterpillars were abundant enough to march in swarms, it has been possible to forestall them by adopting the well known methods used against the true Army-worm, namely, running a deep furrow in advance of them, burning them in wind-rows of straw, or poisoning them by spraying a strip of the vegetation before they reach it, with a strong poisonous mixture. In gardens, they may be advantageously combated by the same methods used against other cutworms. Owing to their large size at the time when garden vegetables are very small, two or three caterpillars can in a single night work terrible havoc in young vegetables grown in rows. This was the case at Ottawa last spring where the larvæ of this species worked at the same time with the caterpillars of the White Cutworm (*Carneades scandens*, Riley, Fig. 13) and the Red-backed Cutworm (*Carneades ochrogaster*, Gn.) and all three species were particularly troublesome in radish beds.

Fig. 13.—The White Cutworm.

THE WHITE-CUTWORM (*Carneades scandens*, Riley), "The Climbing Cutworm" of Dr. Riley, is an uncommon species at Ottawa and has not been sent in from elsewhere, although it is recorded as having done much damage to orchard trees in Western Ontario some years ago. The full-grown caterpillar measures about $1\frac{1}{2}$ inches in length. Its general colour is a pinkish white. The head, the thoracic feet and the thoracic and anal shields are yellowish-brown, dotted with minute black points The spiracles are deep black and the piliferous tubercles very dark, but not so black as the spiracles. This cutworm is easily recognized by its delicate whitish almost glaucous colouring. I was surprised to find it in large numbers at Ottawa in a garden with only two small poplar trees growing near. These were in no way injured, but it seemed as though the cutworms spread from a bed of Couch-grass (*Agropyrum repens*, Beauv.) which was growing at the base of one of these trees. The White Cutworm passes the winter about half grown, but in the piece of sandy land where the attack

referred to occurred some individuals did not revive until a surprisingly late date last spring, namely, the end of May. Some half grown specimens were dug from the bed of Couch-grass in November last. The moths expand about 1½ inches across the wings. The general colour of the forewings is pearly bluish-gray, tinged in some specimens with pink or brown scales; different specimens vary very much in distinctness of the transverse lines, but all show a well defined white subterminal line shadowed on the inner side by a row of dark triangular marks, and the reniform spot shows more distinctly than any of the other markings. Hind wings whitish, with a broad, pale fuscous band and discal spot. Head and body concolorous with the forewings.

Remedies.—When it is known that cutworms are abundant in gardens or even in fields, much can be done by the use of well-known and well tried remedies to destroy them and prevent injury. Several correspondents have borne testimony to the benefits of clean culture, by which all haulms, vines, stems and leaves of crops which had been gathered were promptly destroyed and the land kept free from weeds, so that the female cutworm moths when egg laying were not attracted to the spot. The banding of freshly set out annual plants, either with rings of paper or tin, has as usual given good results. An enterprising Ottawa firm, Messrs. Taylor and Gilbert, has put out a device made of a specially prepared stiff paper 10 inches long by 3 wide, called the Taylor Plant Protector for tobacco, cabbage, tomatoes, etc. These are stated to be a sure protection against cutworms, cold winds, light frosts, etc. The price, less than $1 a thousand, brings them within the reach of all. A great many were used at the Experimental Farm both in this Division and by the Horticulturist and were found to be extremely satisfactory. Cutworm injuries are of so much interest to every grower of vegetables, flowers and fruits in all parts of the Dominion, that I think it well to draw attention to the above device. I may mention that identically the same thing has been used for many years by Mr. George Thurber, of Upton Village, Que., to protect tobacco plants from frosts and cutworms.

The most striking results have been obtained from the use of the poisoned bran remedy, which consists of a mixture of bran and Paris green in the proportion of 50 of the former and 1 of the latter. In making this mixture (which may be applied either wet or dry) it is best to dampen the bran slightly with water containing a little sugar. After mixing thoroughly, so that the whole mass may be permeated very slighly with moisture, add the Paris green by shaking on a very little at a time and stirring it in. If the Paris green be added to the bran when it is perfectly dry, it will, owing to its weight, sink at once to the bottom when stirred. If it is desired to use this mixture as a wet application, more sugar and water must be added until it is of about the same consistency as porridge; but if to be used dry, a little more dry bran may be added until the mixture will run through the fingers easily. Mr. F. A. Sirrine, of Geneva, N.Y., drew attention to the fact that the mixture could be used dry with even better results than when applied wet. It is far easier to distribute and lasts longer without getting mouldy. A convenient implement for distributing this poisoned mixture, among crops which are grown in drills or rows, is a combined wheel hoe and seed drill. The seed box is filled with the poisoned bran, and lines of it are run across the field or along the rows close to the crop. In sandy land it was found convenient first to run a shallow furrow and then drop the bran into this shelter, which prevented the bran from being blown away by the wind. Strange as it may seem, it certainly appeared as if the bran mixture was more attractive to the cutworms than the living plants.

This remedy is, after all, only a modification of the poisoned trap remedy which has been used so successfully for many years, and which will continue to find favour with many, as green succulent vegetation suitable for the purpose is nearly always to be had, for it must be remembered that any weed will answer the purpose, whereas bran or shorts would have to be purchased.

THE CUTWORM LION *(Calosoma calidum*, Fab.*)*.—Cutworms have many enemies. In addition to various insectivorous birds and small mammals, there is a host of parasitic

Fig. 14.—Cutworm Lion beetle.

and predaceous insects which hunt them out and devour them. One of those most often inquired about is the Fiery Ground beetle (Fig. 14) and its voracious black grub, the Cutworm lion (Fig. 15). Specimens of these are sometimes sent in by observant correspondents. The beetle is a large showy and bold species, which is seen in pastures running about quickly and hunting for its prey. Too often, we fear, through ignorance as to its good offices it is destroyed by the many thoughtless people who seem to think that every insect seen should be stepped upon and killed. The appearance and habits of this good friend of the husbandman should be known to every one. The beetle is truthfully portrayed life size at fig. 14. It is a brownish-black beetle, having the wing cases spotted with coppery red in nearly all of the eastern specimens, although occasionally a green spotted specimen is seen. In British Columbian specimens the spots are almost invariably green, the red spotted form being exceedingly rare. Both as a perfect beetle and as a grub (Fig. 15) this insect destroys enormous numbers of cutworms. The following letter is similar to many others which have been received concerning this useful insect:

Fig. 15.—Cutworm Lion.

"Mattawa, June 25.—I applied to you last June for instructions how to fight the cutworm which had made a complete havoc of my garden, and I received your valuable treatise on insects that are destructive which gave me valuable instructions. I followed your advice and kept down weeds during the later summer and in the fall. After I got the crops off I cut all weeds in field corners, raked them up together with all potato tops and other refuse and burnt all; the result is that this year, while the cutworm has destroyed everything in my neighbours' gardens, they have troubled me very little; in fact, nothing to complain of, for of 2,000 plants transplanted, I have not had two per cent loss caused by the cutworms, and in plants grown from seed what little harm they may have done was not perceptible. I inclose you a specimen of a little insect that seems to be a mortal foe to the cutworms. One day recently I noticed a cutworm making very fast movements and contortions, so I picked it up and found one of these insects fastened to it just at the back of the head. I put both into a tin can and watched for the result of the combat. Several times I caused the insect to loosen its hold and placed each as far as possible apart; when the insect was let go it would immediately attack the cutworm again, always trying to fasten about the back of the neck. The result was that the cutworm was dead in twenty minutes. On Thursday last I found the inclosed specimen and then secured a cutworm and put both into a can, when the combat of the few days previous was renewed, with the same result. I put two more cutworms, one each time, into the can, and the black grub killed both."—[C. G. Hurdman.]

THE PEA MOTH (*Semasia nigricana*, Steph.).—In previous reports I have referred to the common injury to green peas, particularly the large late garden varieties, by the caterpillars of a small moth. During the past summer this insect was found in many districts, where it had doubtless always occurred, but from which no reports had been received. One of the localities where the insects has done most harm is Constance, in Huron Co., Ont. Mr. John McMillan, M. P., puts the loss in 1897 at no less than one-third of the crop. Up to the present no specimens of the moth have been caught in the field, but some specimens were reared in the insectary during 1897, which emerged between the 12th and 15th of July, and last summer three more specimens emerged at the same dates, namely, from 13th to 15th July. This would indicate that the natural time for egg laying is not till after the middle of July. Therefore, if peas are planted in good time and of early varieties—of which there are now several of high quality—good crops of green peas for the table can be secured before they are liable to be attacked by the caterpillar of the Pea Moth. At Ottawa several varieties of the small early peas can be picked by the first week in July, and the first crop of all the

best large varieties before the end of the month. The caterpillars of the Pea Moth would not be large enough to enter the pods and injure the green peas at earliest before the end of the month; consequently, at Ottawa and in localities with the same summer climate, green peas for the table can always be grown if early varieties are chosen and seed is got into the ground in good time. Mr. W. T. Macoun, Horticulturist of the Central Experimental Farm, has furnished me with the following list of what he considers the six best early varieties and of the dates when they were ready for picking:—

Alaska	June 17	Gradus	June 18
American Wonder	" 17	Nott's Excelsior	" 20
Gregory's Surprise	" 17	McLean's Little Gem	" 23

In his annual report for this year is given a list with dates of maturing of 25 of the best varieties of all kinds. Where peas are grown for the seed they will be injured in districts where the Pea Moth is prevalent. Experience would indicate that early sowing is in all cases advantageous, but it is also possible that late sowing, so as to hold back the podding, if possible, late enough to escape the season of egg-laying, might give a crop of uninjured seed.

THE PEA WEEVIL (*Bruchus pisorum*, L.).—This perennial pest is, year after year, the cause of enormous loss, notwithstanding the fact that millions of the beetles are destroyed every season in the "bug houses" of the large seed dealers. Prof. C. C. James says in his November *Crop Report*:—"Pease seem to have been the most unfortunate of the grain crops. The drought of the early part of the summer and a frost about the 10th July told upon the growth, and the bug made its appearance in nearly every section of the province. Some of those reporting are inclined to take a discouraging view of the outlook for pea growing, owing to this pest."

It is probable that there has been some confusion in the reports of which the above extract is a summary, between the injury of the Pea Weevil and that of the Pea Moth. The distribution of the Pea Weevil is very much more restricted than that of the Pea Moth, and there are large areas in the province of Ontario where the highest quality of seed pease can be grown without any danger of infestation by the Pea Weevil.

THE BEAN WEEVIL (*Bruchus obtectus*, Say).—*Attack.*—Small beetles closely resembling in shape and movements the Pea Weevil, but only half its size, namely, $\frac{1}{10}$ of an inch long, oval in form, with the head bent down and more or less concealed as seen from above, and prolonged into a short squarely cut snout. Antennæ distinctly jointed and enlarging towards the tip; the first 4 and the last joints reddish. The wing covers marked with ten impressed and dotted longitudinal lines. The whole body covered with short silky hairs. The lines on the wing covers are broken up into pale yellowish dashes and dark brown spots. The tip of the abdomen extends beyond the wing covers and is of the same reddish tinge as the tips of the antennæ and the legs, but is covered more or less with short silky hairs and bears a central white line, but there is no appearance of the two black spots which are so conspicuous in the Pea Weevil.

The life-history of the Bean Weevil differs in some important points from that of the Pea Weevil. The eggs of both are laid upon the pods while these are young and tender. On hatching, the young grub of the Bean Weevil eats its way inside and penetrates one of the forming beans, several grubs entering a single bean, each one forming for itself a distinct cell. They become full-grown and change to pupæ in the autumn and a little later to the perfect beetles. The date of emergence from the seed depends very much, as in the case of the Pea Weevil, on the temperature in the autumn months; it may be in the late autumn or not until the spring; when the seed beans are stored in a warm building, the beetles may emerge at any time through the winter. One of the important differences between the life-histories of the Pea and Bean weevils is that whereas in the case of the former the young grubs can only enter the soft green seeds, those of the Bean Weevil can propagate for three or four generations in the dry stored seeds. This fact renders the well known domestic remedy for the Pea Weevil of holding over the seed for two years quite ineffective in the case of the Bean Weevil; that is, if a

bag of pease infested with Pea Weevil were put away for two years, the Pea Weevils would emerge the first spring and die in the bags. But, in the case of a bag of beans infested by the Bean Weevil kept in the same way, the beetles on emerging would at once set to work laying eggs upon the beans. The young grubs when hatched would penetrate the dry seeds and go through all their stages, and this breeding might be repeated as long as the supply of beans lasted. Curiously enough, the Pea Weevil does not bore holes through the paper or cotton bags in which infested seed has been stored, but in the case of the Bean Weevil such bags are readily perforated and the beetles escape,—frequently, when this happens in houses, as is sometimes the case, to the great consternation of the inhabitants.

The Bean Weevil seems to be a cosmopolitan species, the original home of which was in Asia. It was probably introduced into America through commerce and has been the cause of considerable damage in various States of the American Union. It has been mentioned in the reports of several United States entomologists, full articles being given by Professors Riley, Popenoe and Lintner. There has been a great deal of discussion as to the proper name of the species. The last decision seems to be that the beetle should be called *Bruchus obtectus* of Say. The Bean Weevil has never been recorded as an injurious insect in Canada until the present year, when I received from Mr. B. Gott, of Strathroy, Middlesex Co., Ont., specimens of the beetles and some seed beans which had been entirely destroyed for seed or food purposes. Each seed had been so perforated and the contents eaten away that it could be crushed with gentle pressure between the fingers. These specimens answered in every particular to Dr. Riley's description of *Bruchus fabæ* given in his *Third Missouri Report*, but authorities now consider that *B. fabæ*, Riley, and *B. obtectus*, Say, are identical.

Mr. Gott stated that the beans had been held over from the spring in strong paper bags and put away in a cool room. At the time of his writing, December, 1898, large numbers of the beetles had been found in his house. They were thought at first to be Pea Weevils, but Mr. Gott noticed that they were different, and after some search found that they came from the bags of beans, of which the paper was perforated with numerous holes.

Remedies.—As in the case of the Pea Weevil, the best remedy for this insect is the destruction of the weevils inside the beans as soon as possible after the crop is ripe. Fumigation with bisulphide of carbon is the best treatment in every way. It must not be forgotten that this liquid and its vapour are very dangerous to use, owing to their extreme inflammability. The most convenient way to fumigate seed is to place it in an ordinary coal oil barrel and pour on the beans one ounce of the bisulphide of carbon for every 100 pounds of grain, then close the barrel tightly, first with a wet canvas or cloth and, on the top of this, boards which should be left undisturbed for two days at least.

The Carrot Rust-fly (*Psila rosæ*, Fab.), mentioned in my last report, has been sent in as having appeared in injurious numbers at two new localities in the province of Quebec and also occurred in small numbers at Ottawa. This year white field carrots were attacked, as well as red ones. The semi-transparent yellowish maggot $\frac{1}{4}$ of an inch long perforates the roots in every direction, leaving dirty brown burrows. The maggots are blunt at the tail end, but taper towards the head, where is a black hooked tip forked at the base, by means of which the maggots burrow their way through the roots. The pupa-case is reddish-brown and, as a rule, is found in the earth outside the carrots. The mature fly is $\frac{1}{4}$ of an inch long, bright shining black with yellow legs and red eyes. There are at least two broods, if not more, in a season.

This is a serious pest of the carrot, rendering the roots quite unfit for table use. Its occurrence, however, has been intermittent, bad attacks one year being sometimes followed the next season by a total absence of injury.

"Knowlton, Brome Co., Que., July 6.—I send you to-day by mail a little box in which are a few carrots badly infested by a small white maggot. Nearly one-third of my patch of carrots are dead from the effects of it, and it is only a few days since they

began eating them. Can you give me any information as to what to do to get rid of them? What is it that lays the eggs? It is something new to me as I never noticed them before."—[J. Raymond Ball.]

"Quebec, Oct. 18.—I send you herewith a White Belgian carrot. My crop this year has been almost ruined by this disease, which you will be able to examine on the samples sent to you. Please tell me what is the matter and how to prevent it."

"Quebec, Oct. 27.—In reply to your inquiry as to whether my crop is the only one in this neighbourhood which has been injured by the Carrot Rust-fly, I beg to inform you that this year is the first that I have known the carrots to be injured by this fly. I secured a superb crop from the same field last year without any trace of the disease. My farm is situated at Ste. Marie, Beauce, and all the crops of carrots in the district have been attacked by the fly this season."—[A. B. Dupuis.]

Remedies.—Spraying the carrots along the rows with kerosene emulsion, 1 part to 10 of water, by means of a knapsack sprayer, or sprinkling along the rows dry sand, land plaster or ashes, with which coal oil has been mixed at the rate of half a pint to 3 gallons of the diluent, or crude carbolic acid at the rate of half a pint in 5 gallons, are the only applications which I know to have been used to any advantage. This should be done once a week through June from the time the roots begin to form and particularly after the rows have been thinned. Late sowing has also been found very useful.

Changing the location of the beds as far as possible from infested land has also been attended with excellent results and this common sense precaution should always be practised, when possible, in the case of all attacks of injurious insects. Where carrots are stored during the winter in sand or earth, this, of course, must be treated to destroy the pupæ which leave the roots and enter the soil to pass their last preparatory stage. Miss Ormerod suggests that this earth might be put into a wet manure pit so as to prevent the hatching out of the flies. Should neither of these methods be convenient, at any rate, the earth might be buried in a deep hole dug in the ground for the purpose.

THE TURNIP APHIS (*Aphis brassicæ*, L.)—One of the worst attacks upon root crops this year has been by the Turnip Aphis. In many parts of Ontario Swede turnips were badly injured. In Manitoba, likewise, an outbreak of this pest was brought to my notice by Mr. Bedford. The following extracts bring out the chief points upon which information was asked by correspondents:—

"Eddystone, Northumberland Co., Ont., Sept. 2.—On account of the very hot weather, lice are threatening to destroy the turnip crop in this part of the country. Is there any cure or preventive for it? Can spraying be successfully done?"—[W. G. Sargent.]

"Sherwood, York Co., Ont., Nov. 25.—In reply to your letter I would state that lice on turnips are not an entirely new pest, but they have never appeared in such numbers or with such destructiveness as this year. They have appeared in past years in small patches and were not considered very damaging. I think the reason that they were so numerous was the dry weather, as we had no rain from 1st July till the beginning of September, and it was exceedingly hot also. It wilted the mangel leaves in some localities. In the townships east and south of us, where they had more rain, the injury to the crop was not so great. In answer to your other question, I notice that the pest was destructive on all soils except perhaps some very low wet soils where sufficient moisture was obtained to keep up a steady growth."—[James H. Keffer.]

"Morden, Man., Sept. 28.—I send herewith a turnip leaf infested with some sort of insect. Last fall the same insect attacked the turnips, destroying the crop entirely. The root starts to decay as soon as the plant is attacked. All the turnips in this district went the same way. I should like to know what can be done to save the crop another year. I am taking up those turnips not already affected.

"Morden, Man., Dec. 28.—When you replied to my inquiry *re* turnip aphis, you asked me whether there had been much damage done in this neighbourhood. I have been inquiring of those who grow turnips, and find that nearly all the turnips in this district were damaged. In some cases the turnips were not attacked till late in the fall, and these were not damaged to any great extent."—[Alfred Bradshaw.]

The plant-louse which does most harm to the Swede turnips in Canada, is the same species which is also sometimes destructive to cabbage and is better known as the Cabbage Aphis. It does not usually appear on turnips until August, and is stated by many correspondents to be worst in dry years. There is a general impression that nothing can be done to prevent injury, and as a consequence these insects are, as a rule, left unmolested and a great loss sometimes occurs.

Remedies.—At the time these plant-lice first appear in fields, they are nearly always found in patches of restricted area. These should be looked for at the time the turnips are hoed and thinned, when good service may be done by simply hoeing out the infested plants and, having pulled some earth over them with the hoe, then pressing it down firmly with the foot. When the plant-lice are too numerous for this simple treatment, the plants should be promptly sprayed with a knapsack sprayer, using as an insecticide kerosene emulsion, 1 part to 9 of water, or whale-oil soap, 1 pound in 8 gallons of water.

ROOT MAGGOTS in turnips are seldom complained of in the West, where radishes are grown to the greatest perfection. Occasionally, however, there is a local outbreak of these troublesome insects. Mr. T. N. Willing, of Sylvan Glade, near Olds, Alta., sends specimens of the Cabbage Root-maggot (*Phorbia brassicæ*, Bouché), which, he says, "are from a larva about $\frac{3}{8}$ of an inch long, whitish with black hooks at end, which feeds in the Swede turnips. From one small turnip I found about 75 had entered the sand in which I had placed the turnip, and were in the pupa form. I inclose some with the flies. I had the turnip in the house about three weeks before these flies hatched out. Quite a large proportion of my turnips were damaged by this fly. I suppose it would be well to change the location of my turnip patch next season."

There were, as usual, inquiries from several other parts of Canada where the maggots of this fly are known to occur injuriously, one of the worst occurrences being along the shores of the lower St. Lawrence in the province of Quebec, where sad havoc was wrought in the gardens of the poor fishermen, who have to depend to a large measure on the products of their gardens. An account of this outbreak was sent to me by Dr. A. Mackenzie Forbes, of Montreal.

Remedies.—A sure remedy for these troublesome maggots is still much needed. Every year they are the cause of much loss in crops of great importance to a large number of people, such as cabbages of all kinds, turnips, radishes, onions, and sometimes beans and corn. A great many experiments have been tried with the object of discovering something of use. Many materials give partial immunity in ordinary seasons, but in bad years everything seems after a time to fail.

With onions and radishes, kerosene emulsion of the ordinary strength, 1 to 9, or carbolic soap-wash sprayed along the rows once a week gave tolerably good results, indeed some of the best results of many applications tried. The carbolic wash was made as follows: Dissolve 2 quarts soft soap in one gallon of boiling water, add 1 pint crude carbolic acid; when required for use, take 1 part with 50 of water. The most satisfactory application, but only to a small measure and early in the season, was White Hellebore or Pyrethrum powder dusted dry along rows of radishes at the time they appeared above ground and once a week afterwards. This is only applicable on a small scale. Experiments with kainit showed that this material assisted the plants very much in outgrowing injury, which in the case of cabbages is of very great importance. Kainit has also insecticidal value; but not, I think, to the degree which is claimed for it. It was tried (i.) broadcasted along the rows of onions and radishes, (ii.) sunk in a drill close to the rows and (iii.) in solution. When sunk in a drill it seemed to give better results than with the two other methods. In solution, when used strong enough to affect the maggots, it also injured the bulbs of the radishes, causing black spots, which afterwards rotted. Onions, however, were not injured, and the treated rows were decidedly better than the untreated. Experiments with cabbages showed that the best results were secured with a mixture of 4 ounces of kainit and 4 ounces of hellebore in $2\frac{1}{2}$ gallons of water, half a teacupful being poured round the base of each cabbage after pulling away the soil down to the true roots and applied in the third week of June, just as soon as the maggots were detected.

Through the kindness of Mr. M. V. Slingerland, of Cornell University, I was supplied with a number of the Goff tarred-paper cards. These are hexagonal pieces of ordinary tarred building paper, 3 inches in diameter, with a slit from one angle to the centre, where there is a star-shaped perforation to allow the placing of the card around the stem of a young cabbage. These were asked for rather too late in the season to give them a fair trial, but the plants upon which they were tried were well protected by them, and all those growers of cabbages who have used them speak highly in their favour.

POTATO INSECTS.

The potato crop in Ontario has been a good one. The seed was got in early and the plants suffered no checks from severe frosts. The Colorado Potato Beetle was less destructive than usual. Fine weather at the time of digging, except in some parts of the Maritime Provinces, allowed the crop to be got in in excellent order. There were very few complaints of insects or potato rot. In Manitoba and British Columbia the only adverse reports were from the drier sections, where in some instances the sets had failed to sprout. This was almost entirely where the tubers had been cut before planting. Moderate-sized whole potatoes had given by far the best results. In the Maritime Provinces potatoes were not so favourably reported upon as usual, owing to the wet autumn. Mr. B. W. Chipman, the Secretary for Agriculture of Nova Scotia, in his November *Crop Report*, says: "The potato crop this season, owing to the rains, which caused a great deal of rot, is only 68 per cent of an average, just the same as last year, but the prices have been fair." In Prince Edward Island where potatoes are a crop of very great importance, Father Burke estimates that there was only half a crop. He says: "The crop came up well and showed every sign of being large. The potato beetle came so late that many thought we were going to escape it. The wet early season was against its spread; later the beetles multiplied fast enough, but were controlled by Paris green, which everybody but those a thousand years behind the age now uses. The potato beetle did no injury to our crop this year." Several correspondents in Nova Scotia, Quebec and Ontario refer to the small losses from the Colorado Potato Beetle, but in Manitoba where this insect is very seldom a serious pest, it occured in injurious numbers in several places and required constant attention.

White Grubs and Wireworms have been reported as doing more harm to potatoes than for many years, and unfortunately nothing can be suggested as a remedy. In Nova Scotia where wireworms are sometimes very destructive in potato fields, it is a practice, when digging or ploughing up a crop in infested land, to pick up the potatoes immediately they are dug, when most of the wireworms will be taken with them from the field. After a short time, the wireworms will leave the potatoes and, if the crop is gathered in sacks or in carts, when the tubers are emptied out the wireworms will be found at the bottom and can be killed.

The FOUR-LINED LEAF-BUG (*Pœcilocapsus lineatus*, Fab.).—A somewhat unusual attack on potatoes, which early in the season appeared as if it might prove serious, was by the Four-lined Leaf-bug at Carrville, York County, Ont. Mr. J. Lahmer sent specimens and told of their ravages on some rows of potatoes which he had seen in a neighbour's garden. In acknowledging receipt the usual remedies for sucking insects were given and the life-history of this particular one was described. Later in the season, Mr. Lahmer wrote that the bugs did not spread further over the potato patch, but merely remained on the plants first attacked or on the bushes near by. The owner of the garden when he learnt that they were not a new pest lost interest in the matter and neglected to apply any remedy. The Four-lined Leaf-bug attacks many kinds of plants in gardens, having a special liking for sage and mint, currants, gooseberries and several other plants. The presence of the bugs is easily detected by the numerous brown spots about as big as a pin's head upon the leaves near the tips of the branches.

Fig. 16.—The Four-lined Leaf-bug.

The remedies consist of (I.) Spraying the nymphs or partially developed bugs which cannot fly, with a strong kerosene emulsion (1 to 6); (II.) The jarring or beating of the nymphs and perfect insects from the attacked plants into open tins containing coal oil and water; and (III.) The destruction of the eggs, which are always laid in the twigs of bushes, particularly the currant, near the tips; these are white, and, as they protrude slightly through the bark, when once seen they are easily recognized again, and thus this attack may be controlled to a large measure by winter pruning.

FRUITS.

The fruit crop of Canada has again been a good one. In Ontario, apples, as stated in the November *Crop Report*, were considered more than sufficient for home consumption; very large shipments were made to England and the United States from the western fruit-growing sections; pears, peaches, plums and smaller fruits were also shipped from many localities. From Nova Scotia, the other large fruit exporting province, Mr. R. W. Starr, of Wolfville, N. S., a successful fruit grower and shipper of many years' experience in the Annapolis Valley, writes: "The spring opened early; fruit trees showed a mass of bloom everywhere, but cold rainy weather set in, bees and other insects could not work and pollination was imperfect, especially among apples. Many orchards that showed much young fruit apparently well set, some ten days later, had the ground covered with young apples, leaving apparently very few on the trees. As the season passed on we had frequent showers, but the total rainfall was not more than usual. All the fruit that set healthily developed rapidly, and the extra size made up largely for lack of numbers; the export will, after all, be a good average quantity, say, 250,000 barrels, and the quality better than usual."

Mr. S. C. Parker, Secretary of the Nova Scotia Fruit Growers' Association, says: "The damage to crops this season by insects has, perhaps, been the least of any season in my experience. All insects noted in the orchard and garden were fewer in numbers than for some years past. The means of combating these different pests and the best remedies have been made so widely known that farmers are on the alert to clear them out when they show themselves. Cutworms were conspicuous by their absence. Curculio did not appear to be as destructive as usual, at any rate, did not materially lessen the enormous plum crop. There were no complaints of Codling Moth or Shot-hole Borer, and the Bud-Moth was not as common as usual. Apples were good, more than usually free from Black Spot; the prices were away up and there was a fair crop. There were two bad enemies, however, of plum trees: the Shot-hole Fungus (*Septoria cerasina*, Peck) has devastated many plum orchards, and I expect to see a lot of dead trees next spring; the Black Knot (*Plowrightia morbosa*, Sacc.) has been very bad. Many have about given over fighting it. With plums a drug on the market, the game is not worth the candle."

With reference to the prevalence of fungous diseases, Mr. R. W. Starr also writes: "In most plum orchards rot set in badly, and as a rule, there was more fruit left in the orchards than was picked for the market. Some kinds were worse than others, especially Lombards; whole orchards also were ruined by Leaf Blight and were bare of foliage when the fruit was two-thirds grown. The Japanese varieties seemed to stand a wet season better than the descendants of *Prunus domestica*, L. Burbank did especially well. Abundance seemed to be rather susceptible to Shot-hole Fungus. Most of our early peaches rotted on the trees. Red Rust Fungus on the quince formed lumps somewhat resembling Black Knot in shape. Currants and gooseberries were stripped of their leaves by a blight, and pears showed more Fire Blight than for many years. You will gather from the above that fungous diseases have been very prevalent. I think we must ascribe this to the dull showery weather. I have wondered how the apples escaped as well as they did. Former experience would have led me to forecast a very different result."

It is satisfactory to hear from Prof. F. C. Sears, the Director of the Nova Scotia School of Horticulture, at Wolfville, N.S., that "Spraying was much more generally practised this year than ever before, and the results were very satisfactory, especially so in the use of Bordeaux mixture to control the Black Spot of the apple and the Shot-hole Fungus of the plum. I held about fifteen spraying meetings in different parts of the province and induced fruit growers to experiment also for themselves. I sprayed some rows and left others. The results have been very conclusive in most cases."

In Prince Edward Island, Father Burke says: "Despite our spraying, we had our share of apple-worm, some sorts of apples being badly injured; the season being so wet, the Bordeaux mixture did not stay on long enough to do its work. Owing to the wet season, there was also a lot of Black Spot, but, on the whole, we have a fair apple crop."

In British Columbia, fruits of all kinds were abundant, but there was much loss from insect pests. The two worst enemies of the apple growers were the Apple-fruit Miner *(Argyresthia conjugella, Z.)*, and the small moth described by Walsh in *First Illinois Report* under the, as it has since been ascertained, rather inapt name of the Plum Moth *(Grapholitha prunivora,* Walsh*)*.

The fruit interests of the Pacific province are well looked after by the energetic officers of the provincial Department of Agriculture. The Deputy Minister, Mr. J. R. Anderson, and his Assistant, Mr. E. A. Carew-Gibson, have done excellent scientific work in investigating the botany and entomology of the province, particularly in solving some doubtful points in the life-histories of important enemies of crops. Mr. R M. Palmer, the Inspector of Fruit Pests, has devoted special attention to the practical questions of orchard treatment, of making known the best remedies for pests and the way to apply them, of keeping the provincial markets clear of infested fruit, and thus incidentally creating a better market for home products. British Columbia is blessed to a remarkable degree with a climate and soil suitable for the production of fruits of many kinds, and the wise and energetic measures which have been adopted and fearlessly carried out by the officials of the provincial government have certainly been attended with much success. Up to the present time, notwithstanding statements to the contrary, the Codling Moth has not been detected in any British Columbian orchard.

The Apple Fruit-miner *(Argyresthia conjugella, Z.)*, which has called for so much attention of late years by its injuries to apples in British Columbia, was again this year the cause of considerable loss. In mixed orchards containing several varieties of apple trees, I noticed last summer that crab-apples were more particularly attacked than the larger kinds. Mr. Palmer makes the following report on the occurrence of this insect in British Columbia during 1898:—

"Victoria, B.C., Dec. 15.—On the Islands, especially in the neighbourhood of Victoria, the Apple Fruit-miner *(Argyresthia conjugella)* has been very prevalent this year. The native crab-apple crop was a failure, and this pest attacked cultivated fruits (apples) to an alarming extent. It preferred cultivated varieties of crab-apples to ordinary varieties of apples, and a much larger percentage of larvæ completed their growth in infested crab-apples than in the finer fruit. The entire crop of many crab-apple trees (cultivated varieties) was completely ruined, being tunnelled in every direction, all through the pulp of the fruit. Every effort has been made to get infested fruit destroyed, as, although in 1896 some loss was sustained from the pest, it was not nearly so large as in this season, and I now apprehend there is some danger of the insect becoming a constant feeder on cultivated varieties at least of crab-apples, and possibly of some others.—[R. M. Palmer.]

An interesting account of a Japanese insect, *Laverna herelella,* Dup., which, if different, resembles in most respects the Apple Fruit-miner in a very remarkable manner, is given with an excellent figure in *Bulletin 10, New Series,* Div. of Ent., U.S. Dept. Agr., by Prof. Matsumura, of Sapporo, Japan. In a foot-note to this article, Dr. Howard has suggested, from the resemblance of Prof. Matsumura's figure to bred specimens of the Apple Fruit-miner from British Columbia, which he was good enough to examine, the identity of the two insects. Although it is true the figure cited and the perfect moths

of the Apple Fruit-miner do agree closely, the habits of the larvæ as given by Prof. Matsumura (*loc. cit*) and as described in my annual report for 1896, differ upon what seem to be such important characters that for the present I can hardly think that the two attacks are by the same species. The writer of the article referred to says that the larvæ live only in apple cores, injuring the seeds, that there is usually only one egg deposited on each apple, and that the cocoons are made in the earth whenever possible.

The British Columbian insect very rarely attacks the cores and seeds of the fruit. There are usually several, two, three or more, larvæ in each apple, and the cocoons are made beneath flakes of the bark on the trees or beneath leaves or rubbish on the surface of the ground.

I have lately received the following interesting note from Prof. Enzio Reuter, of Helsingfors, Finland, on the occurrence of *A. conjugella* in Europe :—"I have read your report with great interest. *Argyresthia conjugella* has during the past summer infested the fruit of apple trees throughout the whole of Finland. This is owing to a total failure of sorb-apples (*Sorbus Aucuparia*, L.)* and bird-cherries (*Prunus Padus*, DC.), in which the larvæ commonly feed."

All efforts to discover the egg or the egg-laying habits of the moth have so far failed, and no proved, practical remedy is yet available. At Mr. Palmer's suggestion, many of the fruit growers in the districts where this insect has been troublesome, have adopted the wise precaution of picking and destroying every apple which showed the attacks of the larvæ.

Prof. Matsumura suggests the catching of the moths of the Japanese insect by suspending large-mouthed bottles containing sweet solutions beneath the trees at night; he points out that these should be closed during the day time so that many useful or harmless insects may not be destroyed.

THE PLUM MOTH OR LESSER APPLE-WORM (*Grapholitha* [*Semasia*] *prunivora*, Walsh).—For many years British Columbian apple growers have referred to a small caterpillar which in every thing but size answered to the caterpillar of the Codling Moth. The insect was not abundant and all efforts to obtain specimens to rear the moth failed. Last year a few were secured by Mr. E. A. Carew-Gibson and successfully reared to maturity. The perfect insect, a small moth, was kindly identified by Dr. L. O. Howard, the United States Entomologist, and proved to be the same insect as was treated of and figured by Benjamin Walsh in his *First Report* as State Entomologist of Illinois, under the name of the Plum Moth (*Semasia prunivora*). Walsh bred specimens of the moth from plums, from the fungous growth known as the Black Knot of the plum, from the Cock's-comb-like hollow gall (*ulmicola*, Fitch) on the leaves of elms, which is produced and inhabited by plant-lice, and lastly from a hollow gall on the leaf of red oak. In addition to the above, the late Dr. C. V. Riley (*Am. Ent.* (*III*), n. s., I, 31) adds that he has bred the moth from galls on oak, from haws, from crab-apples and abundantly from cultivated apples. I have at different times bred the moth from apples and haws at Ottawa, from near Toronto and from Lachine, Que. I can find no reference in recent publications to serious injury to either apples or plums by this moth. Single specimens of the caterpillar have been sent in occasionally from Quebec and Ontario, but, as far as I am aware, they have never been sufficiently abundant to be more than noticed by the curious. Last year, however, Mr. R. M. Palmer expressed fears, from the numbers he was finding in British Columbian apples, that the insect might develop into a pest of importance. At that time he complained only of the commonest form of attack by the caterpillar, which is to feed beneath a web upon the skin of the apple, around and inside the cup at the calyx end, or occasionally to burrow more or less extensively under the skin. When visiting British Columbia last summer, in the last week of July, I was shown by Mr. Carew-Gibson a large number of apples which had been handed over to him by Mr. Palmer, which were very seriously infested, both by this insect and also by the Apple Fruit-miner. Upon cutting open several of the infested apples, I was surprised to find how exactly in many instances the work of

* In this country called "Mountain Ash" or "Rowan tree."

the larvæ of *G. prunivora* resembled that of the Codling Moth (*Carpocapsa pomonella* L.). Not only was the skin and flesh just around the calyx eaten, but the apple wa bored into extensively, the core being frequently reached and the pips eaten in precisel the same way as is done by the Codling Moth caterpillar. Every specimen was examine carefully and proved to be *G. prunivora*. This same fruit was also found, as state above, to be badly infested by the Apple Fruit-miner, as well as the Lesser Apple-worm both kinds occurring in the same apple.

"Victoria, May 8.—The specimen that I am sending is the only adult that I hav managed to rear; you will note in size it is not more than half the size of the Codlin Moth; it has also different markings and its larva never reaches more than half the siz of the Codling Moth larva when full-grown. This is the insect whose larva is so ofte mistaken in this province for the larva of Codling Moth and reported as such. It fairly common in some spots, but owing to its size cannot do so much damage to th fruit it attacks."—[E. A. Carew-Gibson.]

"Victoria, Dec. 15.—The larva of *Grapholitha prunivora* has been found this seaso widely distributed all through the lower mainland and the Islands as well. Althoug usually attacking apples, feeding at the calyx end of the fruit for about ½ an inch dow it is also often found inside the fruit, and has been been frequently mistaken for t larva of the Codling Moth (*Carpocapsa pomonella*). It has also occurred quite often plums and prunes, and specimens of fruit so infested have been sent in or collected fro the whole of the districts named.

"This pest and the Apple Fruit-miner evidently need more attention at the hand of our fruit growers in the future than has heretofore been accorded them. In the ca of the Lesser Apple-worm, I think that spraying with Paris green as for the Codlin Moth may be of considerable value. I shall be glad of any suggestion you can make to dealing with these pests.

"A large number of the larvæ collected this season have been carefully attend to by Mr. E. A. C. Gibson, and it is hoped that a number of specimens of the perfe insects and perhaps some parasites will hatch out in the spring. Many specimens of fru collected contained larvæ of both species."—[R. M. Palmer.]

From the past history of this insect, particularly in British Columbia, and after tal ing the matter over with Mr. Palmer and Mr. J. R. Anderson, who three years ago fou numbers of apples badly infested in Capt. Gaudin's garden, at Victoria—from whic however, the insect has since entirely disappeared—I think it hardly likely that t caterpillar will develop into a serious pest of apples or plums. It is probable that t injuries of this year, which are certainly exceptional, were due to the failure of the w crabs to produce fruit this year in British Columbia, and that both this insect and t Apple Fruit-miner were driven to cultivated fruits, as it is related in Dr. Reute interesting letter was the case with *Argyresthia conjugella* in Finland this year.

Should injury by the Lesser Apple-worm continue, I have no doubt, as suggested Mr. Palmer, that spraying with Paris green should be the first remedial experiment tri

Notes on the Lesser Apple-worm, by Mr. E. A. Carew-Gibson.

Aug. 16, 1897.—Received from Hornby Island, a number of apples infested w a small boring worm.

Sept. 17.—Found six larvæ from above apples spun up, five in the paper beneath apples, using the paper fibre for their cocoon, and one spun up on the cork of a sm specimen bottle using cork dust for its cocoon; all the spun up larvæ at this d unchanged. The specimens are ⅜ inch long, $\frac{1}{16}$ inch in diameter, tapering sligh towards both extremities; reddish pink to pale pink in colour, lightest in colour betw the segments. Head smaller than 1st segment, with blotchy darkish brown markin thoracic and anal plates also darkish, marked with brown. Body covered with w bristles, with finely dotted surface to the skin (under the microscope). Surface w lumps and depressions. Very active when placed in the sunshine, evidently at o seeking shelter for spinning up. The larva spun up on the cork very closely covered with cork dust.

May 7, 1898.—One very active little moth emerged.

E. A. Carew-Gibson.

The moth expands about $\frac{5}{8}$ of an inch across the wings. The ground colour of the front wings is black, with large patches of rusty red and a central steel blue blotch. Along the costa are seven very conspicuous short white streaks, arranged 2, 2 and 3 together, of which the longest are the 1st, 3rd, 5th and 7th; these streaks are nearly parallel to each other and are obliquely directed toward the posterior angle of the wing. The hind wings are dusky gray at the base, shading into black at the tip.

The other insects which have attacked fruit trees during the past summer are well known species. Of these none have called for more attention by their excessive numbers than the TENT CATERPILLARS, which swarmed on forest and orchard trees in many sections of almost every province of the Dominion.

Enormous numbers of Tent Caterpillars of the two common species, the Forest Tent Caterpillar (*Clisiocampa disstria*, Hbn), and the American Tent Caterpillar (*C. Americana*, Harr.), occurred in the woods and on trees in gardens and orchards for many miles around Ottawa and through the counties of Carleton, Russell and Grenville; nor were they confined to this part of the province, for specimens or letters of inquiry came in from every direction. Aspen poplars, maples and basswood seemed to be the favourite food plants, but where the caterpillars were abundant the foliage of all plants was eaten.

Fig. 17.—American Tent Caterpillar.

"Victoria, B.C., Dec. 15.—On the Lower Mainland the most troublesome pests of the season were the Forest-tree Tent Caterpillars. They were present in countless thousands and fruit trees in proximity to native trees such as alders and willows, where the pests hatched undisturbed, were in danger of being defoliated, even when considerable attention was devoted to fighting the pests. Fruit trees from which the leaves were eaten, put on foliage again later in the summer, but went into winter in poor condition to withstand vicissitudes of weather. Fortunately, by far the larger proportion of the larvæ were parasitized and egg masses of the pests are not nearly so numerous as last year; besides this, fruit growers were roused as a rule to the danger from these voracious insects and better prepared to fight them both by the destruction of eggs during the winter months and by means of Paris green spraying later on."—[R. M. Palmer.]

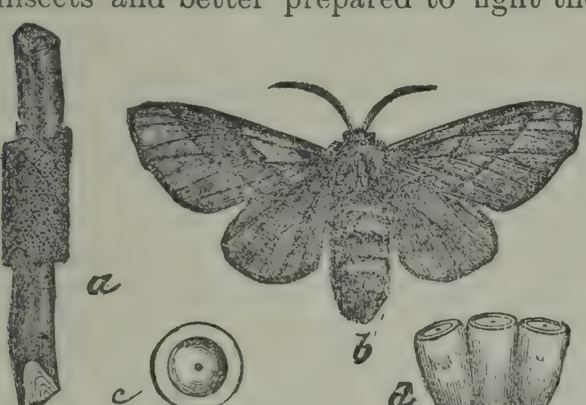

Fig. 18.—The Forest Tent Caterpillar: *a*, egg cluster on twig; *b*, moth—natural size; *c*, *d*, eggs—enlarged.

When I was in British Columbia last August, Mr. T. A. Sharpe, of Agassiz, drew my attention to the fact that a very large percentage of these caterpillars had been destroyed by a very fatal disease after they had spun their cocoons. He examined one hundred cocoons before he found one containing a living pupa. Unfortunately no such state of affairs happened in the Ottawa outbreak, for at the present time the egg clusters (Figs. 18*a* and 19) are to be found abundantly on trees and shrubs in every direction. On one small cherry tree 10 feet high, I collected no less than 37 egg clusters. The eggs in every one of them appeared to be in a healthy condition, and the young caterpillars hatched out in thousands in my office. There is the greatest necessity for all who wish to save their trees to take steps next season, in the first place, to clear from the trees during the winter such eggs as can be reached, and to provide themselves with spraying apparatus so as to be ready to destroy the caterpillars

Fig. 19.—Egg cluster of the American Tent Caterpillar.

next spring while they are still small, using the ordinary standard mixture for foliage-eating insects, namely, 1 pound of Paris green, 1 pound of quick lime, and 200 gallons of water.

The Plum Curculio (*Conotrachelus nenuphar*, Hbst.).—Plum growers have pretty generally adopted spraying with Bordeaux mixture and Paris green as the best remedy against the Plum Curculio upon plums. The treatment, however, is by no means claimed to be a perfect remedy, although I believe that the saving in the quality of the crop will always make it pay handsomely to spray plum trees, and in the mean time it is the *best* remedy. The fact that most of the large plum growers have adopted spraying as a regular practice speaks for itself and shows that it pays them to do so. Spraying cherries and peaches has not been quite so satisfactory as in the case of the plum, and upon the apple to which the Plum Curculio is sometimes very destructive it would appear that spraying is even less effective. Nevertheless, it pays to spray as in the other cases.

In October last, I received through Mr. W. T. Macoun, some specimens of apples which had been utterly ruined for the market by the Plum Curculio, being gnarled and indented wherever the beetles had bitten ("stung") them. At the same time the growers of the apples, Messrs. R. Jack & Sons, of Chateauguay Basin, Que., sent a bottle filled with specimens of Plum Curculio taken on the apple trees from which the injured fruit was sent. Messrs. Jack & Sons write :—

"Chateauguay Basin, Que., Nov. 8.—You ask if plums are badly affected by Curculio with us. They are, very badly, both on the farm and all round this section of country. I have known the pest sometimes to destroy the whole of the crop on some of the trees. You ask also whether the female uses the young apples to deposit her eggs in. That is the way in which most damage is done. Sometimes we have not been able to find a sound apple on some trees with about a bushel of apples on. Most of the apples had eggs deposited in them or had been punctured, and some of the apples would have as many as three or four eggs in them. We have noticed some apples injured within two or three days after the blossoms have fallen. We notice very little difference between sprayed and unsprayed trees. They seem to be very little affected by Paris green. Last season we used Paris green in the first two applications of Bordeaux mixture, *i.e.*, once before blossoming, and immediately after the blossoms had fallen, at the rate of 8 ounces to 50 gallons of water, and still they injured great quantities of apples. The kinds which they seem to have a preference for are Duchess, Yellow Transparent, Astrachan, Grimes Golden, and Golden Ball, but if these kinds are scarce they work on the other varieties. In fact, the Curculio does us more damage than all the other pests and fungous diseases combined. A good many apples fall prematurely with the larva in them. Do you think it would be any advantage to pasture the orchard with sheep, so that they would eat the fallen apples and so destroy the grub? We send you under separate cover samples of apples which have been injured by them."

"November 18.—Your favour of the 12th instant to hand. In it you ask how long it is since we noticed the Curculio destroying the apples. We would say that it is about six or eight years since we have noticed them doing any injury to any extent to apples, but they have troubled the plums for a good deal longer period. They also do considerable damage to cherries. We have along one of the line fences between our neighbour and ourselves, a row of common red plums which have been infested with Curculio as long as we can remember, but the place where the Curculio is worst is at the other side of the orchard. We intend to have these old plum trees cut down this fall and have the land cultivated for a couple of years. There is in a field next to the orchard a clump of hawthorns of which the haws have been infested with little grubs, but we have never experimented to see if they were Curculio or not. Perhaps you could give some information ? I notice that the Curculio does not seem to do so much damage where the trees are cultivated often."—[R. Jack & Sons.]

The above letters were in reply to questions which are well indicated by the answers given. Some of the apples forwarded by Messrs. Jack had from 5 to 25 punctures and were utterly useless for the market. It is well known that the Plum Curculio lays

its eggs in apples and that the larvæ can develop in this fruit, but most of the injuries in this case were of the nature of a hollow cavity beneath the skin, the flesh appearing to have been eaten out through a central orifice. Frequently these cavities were at the bottom of deep depressions, and there were no galleries in the flesh of the apple. That the injury to apples extended further than the immediate vicinity of Chateauguay Basin was shown by my receiving specimens injured in exactly the same way from Professor L. R. Jones, of Burlington, Vt., with the information that the injury was quite common on Baldwins and Greenings and that considerable injury had been caused in the State of Vermont. The advantage of attending to windfalls, either by collecting them or pasturing sheep or pigs in the orchard was pointed out, and the opinion was expressed that the grubs which had been found in the haws were more likely to be those of the true Apple Curculio *(Anthonomus quadrigibbus*, Say.) than of the Plum Curculio. The fruit of the hawthorn is nearly always infested by *Anthonomus quadrigibbus*, and, as far as my own experience goes, it is a very rare enemy of the apple. As a remedy for this attack on apples by the Plum Curculio, nothing further can be suggested than spraying the trees regularly with Paris green, beginning early and continuing as late as possible through the season. Where it is practicable, jarring the trees over large sheets placed on the ground and then destroying the beetles will, of course, reduce very much the amount of injury.

THE GREEN FRUIT-WORMS (*Xylina*).—The larvæ of two or three species of this genus were unusually abundant and destructive in some parts of Ontario last summer. Mr. W. M. Orr found them in many orchards when superintending the Provincial Government spraying experiments. He estimates the loss from these caterpillars at between 20 and 30 per cent. Mr. N. H. Cowdry, of Waterford, Norfolk County, Ont., sent specimens of the caterpillars, together with their work on young apples and pears. He said: "They seem to feed exclusively on the young fruit to which they are exceedingly destructive, but they do not touch the foliage. They are very numerous about here, and, owing to their habit of eating the fruit only, are hard to destroy by spraying." An account of injury by Green Fruit-worms, was also received from Mr. John A. Link, of Sombra, Lambton Co., Ont.

Fig. 20.—A Green Fruit-worm: *a*, caterpillar; *b*, moth.

At Aylmer, Wright Co., Quebec, large silver maple trees (*Acer dasycarpum*) and to a smaller degree other trees and shrubs growing near were almost defoliated by the larvæ of a species of *Xylina*, which were in such numbers that every tree trunk and fence was swarming with them in the third week in June, as they moved from tree to tree in search of food. Almost all the specimens collected died from injuries inflicted upon each other in the breeding jars. A single specimen of the moth was reared which seems to be *Xylina Grotei*, Riley. The caudal end of the pupa resembles that of *X. laticinerea*, Grote, as figured by Mr. Slingerland on Plate II. of his Cornell University *Bulletin 123*, except that the cremastral spines are less pronounced.

Another outbreak, not quite so severe as the one above mentioned, occurred at Niagara on the Lake, where large maples planted as shade trees were covered with these caterpillars to the great inconvenience of passers by in the streets. In this case, I think it hardly possible that many of these larvæ could have reached the perfect stage, for the trees were visited incessantly by warblers and other insectivorous birds who vied with a swarm of English sparrows in the branches above and numerous chickens on the ground below, in destroying every caterpillar that moved. It is several years since these insects have been abundant enough to call for special treatment, but similar outbreaks to those mentioned upon forest and shade trees occurred in the vicinity

of Ottawa in 1885. The caterpillars of three distinct species of moths are known by the name of the Green Fruit-worms. These resemble each other very much in appearance and habits. They are discussed in detail by Mr. M. V. Slingerland, in his characteristically careful and accurate manner, with beautiful figures, in Cornel University *Bulletin 123*. The caterpillars may be described generally as cylindrica in shape with heads almost as wide as the body. Colour, pale leaf green, striped longitudinally and dotted with creamy white. The full-grown caterpillar measures from 1½ inches to 1½ inches in length by ¼ of an inch in diameter. The food consists of the leaves of the apple, pear and several kinds of forest trees; the maple, poplar, hickory wild cherry, box elder and the buds of roses are recorded among their food plants Their greatest injuries, however, are to the fruit of apples and pears.

The moths vary considerably in appearance, but are characterized by the colo ash-gray colour of the front wings, which are variegated with darker gray. The most constant characters seem to be: a pale space at the base of the front wings and on the upper half, the pale upper part of the orbicular spot and the dark sub-terminal line The expanse of the wings is from 1½ inches to 1¾ inches.

"The moths are night fliers, remaining concealed on the bark of the trees or in secluded places during the day. Most of them appear during September and October and, hibernating in sheltered places, appear again in March, April and May; some evidently remain in the ground as pupæ over winter, the moths not appearing until spring. They are readily attracted to lights or sweetened baits at night, and are 'often found in maple groves while sugaring is going on. Sometimes sap-pails are found in the morning with the surface of the liquid completely covered with the moths.'" (M. V. Slingerland, *Bulletin 123.*)

THE SAN JOSÉ SCALE (*Aspidiotus perniciosus*, Comstk.).—Since the passing of the San José Scale Act, on the 13th of March, 1898, every effort has been made, both by the Federal Government and the Provincial Government of Ontario, to detect any occurrence of this extremely injurious insect and to eradicate it with as little delay as possible. A thorough examination has been made of that section of the province of Ontario in which it was known that colonies of this scale insect had been found in 1897 Wherever infested trees were detected, they were dug up and destroyed. Trees known to have been imported from States or nurseries in which the scale had occurred during the last few years were followed up and examined in the orchards where they had been planted. It is satisfactory to know at the conclusion of this inspection that the prevalence of this insect in Canadian orchards is far less than it was feared last spring might be the case. The only locality where a new occurrence of special interest, from it northern latitude, has to be recorded is at Guelph, Ont., where the winters are sometime very severe, the thermometer occasionally falling as low as 15 degrees below zero, Fahr The scales in this case were imported on pear and plum trees and had passed through a least two Canadian winters; although the scales had survived, they had not spread to othe trees. The passing of the San José Scale Act has naturally given rise to a great dea of correspondence as to what kinds of plants come within the provisions of this Act and are prohibited from being imported into Canada from any country where the San José Scale is known to exist. In framing this Act, great care was taken by the Hon Minister of Agriculture to interfere as little as possible with established lines of trad and only to prohibit such plants as it was thought were a source of danger to thi country. It is known that the San José Scale is liable to occur in a living state, an that thus it might possibly be introduced, upon any woody-stemmed tree or shrub, excep conifers, the stems of which do not naturally die down to the ground every year. Suc plants, therefore, may not be imported into Canada from any country where the San Jos Scale has been found. A very few exceptions have been made to this rule in the case o some plants which are only grown in greenhouses. These exceptions were authorized b Order in Council at the time of the passing of the Act and made public through th *Canada Gazette.* They have also been published in the reports of the Entomologica Society of Ontario, of the Fruit Growers' Association of Ontario, and of other societie No further exceptions to the Act have been made, and in the case of such plants a

raspberries and some other small woody-stemmed shrubs it was considered wise by the Hon. Minister, for the present at any rate, not to allow these to be imported, even when cut right down to the roots, for fear that this cutting might not be done thoroughly enough. True herbaceous perennials, like the perennial phlox, dahlias, herbaceous paeonies, and perennial asters, the stems of which die back right down to the roots every autumn, can be safely imported and consequently are not prohibited. The scale has been known to spread occasionally on to several plants with herbaceous stems, but as it can never move again after once settling down on any plant, which it does within two days after birth, and as during its active life it must constantly be supplied with liquid food, even, were it introduced in the dormant condition in which it passes the winter on the stems of herbaceous perennials which had died down naturally, such scales could never revive nor propagate; in the first place, they would have no food in the dead, sapless stems, nor could they move to search for it elsewhere, owing to the scales which they have formed over their bodies since they settled down, and also to the important fact that very soon after settling they undergo their first moult, from which time they are absolutely without legs or other means of locomotion. In the second place, they could not propagate because they pass the winter in a half grown condition, and being deprived of food it is impossible for them to reach maturity.

The question is frequently asked at farmers' meetings when specimens of the San José Scale are shown on pieces of twigs and branches, whether there is not danger of introducing the scale into new localities by this means. For the reasons given above, there is manifestly no danger to be feared in this direction. The only way in which the scale can be spread is by the migration of the young insects during the short time that they are able to crawl about. The sap in any piece of infested wood which could be conveniently taken to a meeting for exhibition dries up in a few hours and very few of the young scale-insects could be born before the females died, even if the wood were taken at the time when the females were bearing young, and then these young insects would have to find their way on to living trees before many hours or they would die. It has been objected that upon wood bearing the Oyster-shell Bark-louse myriads of the young have been found moving several weeks after the scale-bearing branch had been severed from the tree. It must be remembered, however, that the habits of the Oyster-shell Bark-louse and those of the San José Scale are entirely different. When mature, the female of the former, before dying, lays beneath her scale a large number of eggs, which remain unhatched for many months from autumn until the following summer, during which time, of course, being eggs, they require no food; so it does not matter how dry the branch bearing them beneath their mothers' scales may be; but whenever these eggs are brought under favourable conditions they will hatch and the young bark-lice appear. With the San José Scale, on the contrary, eggs are never laid, but the females bring forth their young alive and at that time must be constantly supplied with liquid food. As stated above, if the scale-bearing wood is removed from the trees during the period of dormancy in which the San José Scale passes the winter, all the scale-insects upon such wood are immature and must soon die. This period of dormancy lasts in Canada, at any rate, from the beginning of November till the beginning of June. Close study of this insect has shown that none but the immature insects live through the winter, and, further, that these do not begin to produce young until after a considerable time of active life and growth the following season.

The keen interest which has been aroused with regard to all insect pests by the advent of the San José Scale has also drawn attention to various other kinds of scale-insects which have been found upon Canadian fruit trees. Many kinds of these have been sent in for examination. The Forbes Scale, the Putnam Scale, the New York Plum Scale and the Scurfy Bark-louse were all found in some numbers upon orchard trees. Although widely spread through the province of Ontario, not one of them was sufficiently abundant in any locality to be considered a serious menace to fruit growers.

In addition to the above, the Oyster-shell Bark-louse is extremely abundant all through Canada and is very destructive.

The standard remedies for scale-insects are kerosene emulsion or whale-oil soap solution (1 lb. in 2 to 4 gallons of water), applied early in the spring, just before the buds open.

APHIDES OR PLANT-LICE have again this year been conspicuous in orchards. In the Niagara district the CHERRY APHIS (*Myzus cerasi*, Fab.), appeared in enormus numbers early in the season and, although it disappeared as mysteriously as it had come, in some places, in orchards of cherries, particularly the sweet varieties, it did a great deal of harm. Mr. C. F. Purdy, of St. Catharines, this year lost heavily from this insect, which in his orchard was far worse than last year. Mr. Martin Burrell, of the same place, writes: "I find in my notes that the Black Cherry Aphis was very abundant on 27th May. Under date of 2nd June, I find: 'Black Aphis breeding rapidly, very few *Syrphus* larvæ or lady-birds'. I have no other notes, but, on the whole, the later injuries were not as bad as in 1897. We used whale-oil soap (1 lb. to 7 gallons) with fairly good results." Mr. R. M. Palmer, of Victoria, B. C., says: "The Black Cherry Aphis was commoner than usual all through the lower portions of the province. It is, too, much more difficult to kill by means of sprays and is not so much attacked by parasites as other species. The quassia spray No. 2, I found quite effective if used hot, as hot as the hand would bear; if used cold, only partially so." The spray referred to is given in the useful pamphlet "Insect Pests and Plant Diseases" issued by Mr. Palmer for the provincial Board of Horticulture and is as follows:—

Quassia chips	8 lbs.
Whale-oil soap....................................	7 lbs.
Water....................................	100 gallons.

"Boil the quassia chips in about 8 gallons of water for 1 hour; dissolve the soap in hot water; strain and mix both solutions together and dilute with sufficient water to make 100 gallons altogether. To be used with a spraying pump, with as much force as possible in applying. This mixture is the standard remedy for Hop Aphis, and has given most satisfactory results against other Aphides with no injury to the foliage of the trees treated."

THE APPLE APHIS (*Aphis mali*, Fab.), like the last named, was unusually prevalent at the time the apple trees were budding and caused much anxiety in Ontario, Quebec and Nova Scotia. The remedies which were recommended were whale-oil soap (1 lb. in 8 gallons of water) and kerosene emulsion (1 to 9); but fruit growers on a large scale were advised to wait until, at any rate, the middle of May, to see if the natural parasites did not reduce the plant-lice sufficiently to make remedies unnecessary. This recommendation I believe from experience to be safe for Ontario, but in British Columbia the Apple Aphis requires treatment as early as it shows itself, for in that province it is a far more injurious pest than in any other part of Canada. Dr. D. Young, of Adolphustown, Ont., during the course of some correspondence about an outbreak of Apple Aphis on his apple trees, writes:—

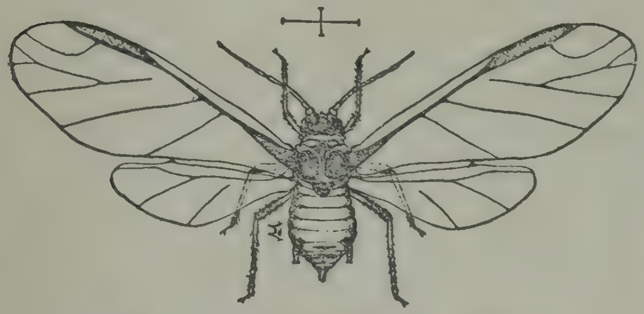

Fig. 21.—The Apple Aphis—enlarged.

"Adolphustown, April 20.—It would take about 270 sixty-gallon barrels of solution to spray my orchard, at 2 gallons per tree, so that I should need 1,065 gallons of kerosene and 266 lbs. of soap, besides the expense of labour. The tobacco spray would cost probably as much. I shall be glad to know whether you think it would pay me to spend a couple of hundred dollars in spraying for this pest or not."

In reply, Dr. Young was advised to wait a week or ten days, and if the plant lice did not increase perceptibly to do nothing beyond his regular spraying for Codling Moth and fungous diseases. Later in the season, I learned that this outbreak had passed away without doing serious harm to the crop.

THE BRONZE APPLE-TREE WEEVIL (*Magdalis ænescens*, Lec.).—Some specimens of apple boughs containing the young larvæ of this insect were received from Victoria, B.C., and Nanaimo, B.C. Mr. Palmer says of this insect :—"These small bark-borers, larvæ of *Magdalis ænescens*, continue to do much harm, especially in young orchards on dry lands of the Island. The lime, soap and carbolic acid wash is effective against them, if renewed at the end of May, but one application made early in spring has not proved sufficient. Many young trees were killed outright or so badly damaged that they will scarcely recover, where preventive measures were neglected."

From what I have seem of the injuries of this weevil, I am of the opinion that while the eggs are generally laid in trees which are in a feeble condition, at the same time they are also found in young and healthy apple trees. The attack by the beetles feeding upon the leaves of cherries noticed by Rev. G. W. Taylor on Gabriola Island last year was again noticed this season to a lesser extent, but appears to be a regular habit of the beetle. This might be taken advantage of for poisoning the mature insects as a means of reducing their numbers.

THE BLACK GOOSEBERRY-BORER

(*Xylocrius Agassizii*, Lec.).

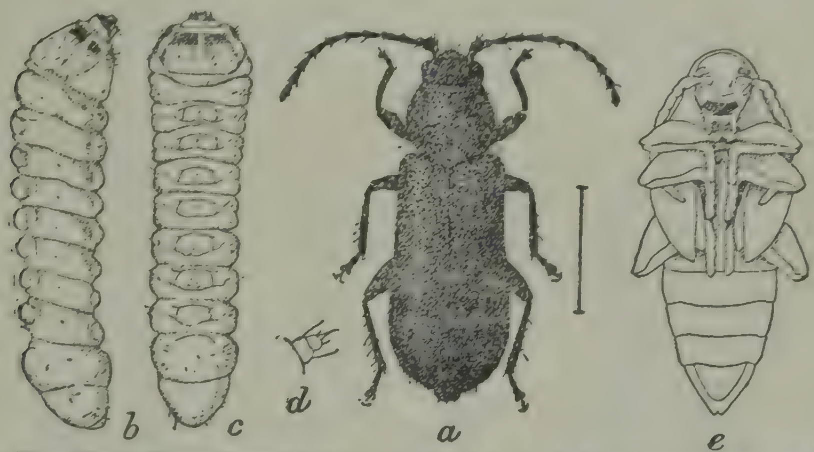

Fig. 22.—The Black Gooseberry-borer : *a*, beetle ; *c*, *d*, larva ; *e*, pupa—enlarged.

One of the most interesting attacks which has come under my notice during the past season is by the extremely rare boring beetle (*Xylocrius Agassizii*), which may be called from the colour of the mature beetle and its habits, the Black Gooseberry-borer. The introduction of this insect into British Columbia, its detection and almost certain extermination by the Inspector of Fruit Pests, and also the successful rearing of the mature insect by Mr. E. A. Carew-Gibson are detailed in the following letters. It is hardly probable that this insect will ever become a serious pest of gooseberries, for it has been so extremely rare in the past that few collections possess specimens, while at the same time its probable native food plants, the various species of *Ribes*, are abundant on the Pacific slope.

"Victoria, B.C., March 1.—I am sending you by present opportunity under separate cover a box containing a bottle with borer grub and remains of roots of some young gooseberry bushes, which you will note have been hollowed out. Can you name this borer for me? I have not seen it nor heard of it before."—E. A. Carew-Gibson.

"Victoria, B.C., March 3.—I am sending you by same mail some specimens of roots of gooseberry bushes infested with a root borer, also a specimen borer in fluid. These plants came from Oregon last fall in a large consignment of plants, part of which —the younger bushes—are not infested, while many of the larger of older growth, are like those sent herewith. I am very glad indeed that the pest has been discovered soon enough to have the infested plants destroyed before the grubs mature, and I am busy now following up this work. I find that to detect the borer the roots must be snapped, which they do much easier than sound roots."—[R. M. Palmer.]

"Victoria, December 31.—In regard to the gooseberry bushes infested with larvæ of *Xylocrius Agassizii*: the plants were sent into the province from Oregon—shipped by the Oregon Wholesale Nursery Co., of Salem, to Victoria, in November, 1897. In all, 500 plants were condemned. These were a portion only of a shipment of

Fig. 23.—The Black Gooseberry-borer: infested stem—reduced $\frac{1}{3}$.

Fig. 24.—Larva in stem—slightly enlarged.

10,000 plants, and every package or bundle of the plants found to contain infested bushes was condemned and destroyed excepting only the specimens which were retained

for investigation, and some of which were forwarded to you. Upon referring the matter to the shippers of the plants, they stated that the stock was not grown by them, but bought from another nursery in their neighbourhood, and that the pest was altogether new to them. Mr. H. E. Dosch, of the Oregon State Board of Horticulture, also wrote in regard to the pest that he had not found it in Oregon in the course of his experience, which would indicate that its occurrence in Oregon as a fruit pest is, at least, unusual.

"I shall be glad to know where the borer belongs, and its usual food plants, if you can supply the information. I had supposed is was a species native to Oregon, and that it probably fed naturally upon indigenous plants.

"I feel quite safe in stating that there is no possible chance of any of the insects from this lot of plants having escaped destruction, but in view of the fact that large quantities of gooseberry bushes have been imported from Oregon for many years past, it is quite possible that it may exist in the province, and I propose to examine closely for it all plants which come under my observation. I am glad to say that Mr. E. A. C. Gibson has been successful in rearing mature specimens of the insect and is forwarding some to you as well as capital photographs of the larvæ and pupæ as they occurred in the plants.—[R. M. Palmer.]

In reply to an inquiry as to the occurrence of the Black Gooseberry-borer as an enemy of the gooseberry on the Pacific coast, Prof. A. B. Cordley, Entomologist of the State Agricultural College, at Corvallis, Oregon, writes: "The attack of *X. Agassizii*, which you describe, has never come under my notice, and I hardly think that this borer could have appeared in injurious numbers of late years in this State, or I should have heard of it."

Mr. Carew-Gibson, who by successfully carrying through to the perfect form three specimens of this very rare insect, has added one more to his triumphs in the investigation of the life-histories of insect pests, has forwarded to me the following notes upon this species:—

Notes on the Black Gooseberry-borer by Mr. E. A. Carew-Gibson.

The gooseberry bushes from which the specimens sent you were reared were brought into this province in a consignment of 500 two year old gooseberry bushes which came from the Oregon Wholesale Nursery Co., late in the fall of 1897. At the time of their importation no signs of the presence of the borers could be detected. The bushes were heeled in when received, and the damage done by the borers was first noticed in the spring of 1898, when the bushes were being planted out. Later on, after a thorough further examination, the whole of this consignment of 500 bushes was condemned by the Inspector of Fruit Pests and, except those bushes kept for experimental purposes, was destroyed under the inspector's direction. On inquiring from the Oregon Wholesale Nursery Co., it was ascertained that these bushes were not really their own stock, but had been bought from a neighbouring nursery to fill up the order.

The larva of which you can form a very fair idea both from the photo I send and from what you saw of them while here this summer, seems able to adapt itself very readily to its surroundings. I have now (31st December, 1898) a grub from the same lot of bushes which I took from a stem on 12th September, when it appeared to be full grown, and placed in a small glass phial tightly corked. It is still alive and wriggling; for the first two months it appeared undecided as to whether it would pupate without further food or not, later it began gnawing the cork of the phial, and it has now worked its way into the centre of the cork. One of the grubs pupated on 19th August (see photo) and the adult beetle appeared on the 18th day after, although at the time it was still soft. On opening another twig on 13th September I found another adult beetle apparently ready to emerge. There only appeared to be a single grub in each affected tree, and as the bushes were small this proved a very wise arrangement, as there would not have been room for more than one. The grub generally starts in from a convenient crotch somewhere about where the branches make a fork, it then works downwards, apparently wintering in the roots, in one case I noticed that it had worked so near to the soil that there must have been only the thinnest possible covering between it and the

soil, it then appears to work upwards in much the same way as the Raspberry Cane-borer, and after reaching some inches above ground, having first made a chamber with only the thinnest possible covering dividing it from the air, it pupates. I am sending you the only additional specimens I have for identification purposes, and these I take to be the larger the female, and the smaller the male; you will note considerable difference in their size. I caged these two beetles on a living bush inside a large glass on my table on 14th September; on the 15th I found an egg resting in the crotch formed by a thorn on one of the twigs, but I lost this egg while examining it under the microscope; it was very small and had its surface beautifully ornamented. 21st September, female apparently dying, male still very active. 22nd, female dead; on the 27th the male was still strong. I could discover no more eggs.

E. A. Carew-Gibson.

The specimens of the beetles sent by Mr. Carew-Gibson proved to be two females and a male of the rare longicorn bettle above-named. I am indebted to Mr. W. H. Harrington and Dr. L. O. Howard for the exact identification of the species. Through the courtesy of Dr. Howard also, the beautiful figure 22 given above has been specially drawn for this report by Miss L. Sullivan, the accomplished Artist of the Division of Entomology, at Washington, D.C, under the supervision of Mr. F. H. Chittenden of the same Division. Figures 23 and 24 are from photographs by Mr. Carew-Gibson.

The genus *Xylocrius* is characterized as follows by Leng in the *Bulletin* of the Brooklyn Entomological Society, vol. VII., p. 113.

"*Xylocrius*, Lec.—This genus presents another remarkable form. The antennæ are very stout, quite hairy, the thorax very convex and rounded at the sides, the elytra constricted behind the base and strongly rounded at tip, and the entire surface deeply punctured and pubescent. Two species have been distinguished:—

More slender; elytral punctures before middle gross, somewhat confluent, surface shining; behind middle, punctures finer, surface opaque.......... *Agassizii.*
More robust; surface all shining; punctures large, foveate, irregular, more or less confluent...... .... *cribratus.*

"*X. Agassizii*, Lec. (*Proc. Ac. Phil.*, 1861, p. 357)—The hair behind the middle of elytra is more dense; 3rd and 4th joints of antennæ about equal. Length, ·45 inch =12 mm. Habitat: California.

"*X. cribratus*, Lec. (S. M. C., 1873, No. 247, XI., p. 172).—Pubescence equal throughout; 3rd joint of antennæ one-half longer than 4th. Length, ·55 inch=15 mm. Habitat: California, Nevada."

The following description was made from the three specimens sent by Mr. Carew-Gibson:—Length, male, ⅜ inch; female, ½ inch. Colour, deep dull black; whole body covered with downy, rather sparse, pubescence; erect bristles on head and thorax; elytra slightly constricted in the middle; thorax and humeral half of elytra coarsely punctate; apical half, velvety, silky, opaque; abdomen of male shiny black, of female piceous; antennæ rather short and stout, of about the same length in both sexes; thighs swollen in both sexes; general appearance between *Asemum* and *Callidium.*

SPRAYING.

From every province overwhelming evidence proves the very great value of spraying fruit trees for the prevention of damage by both injurious insects and fungi. Owing to the large amount of capital invested in fruit farms and the permanent nature of the plantations, a great deal more attention has been devoted to the enemies of fruits than to those of any of the other ordinary crops which occupy the land for only one or two years, or even less. The consequence is that the habits of these pests are pretty well understood and standard practical remedies have been devised for most of them. These have been made known widely by means of official reports, agricultural periodicals and the daily press.

Up-to-date fruit growers know well the advantages they derive from attending carefully to the work of spraying their crops. It is very seldom now-a-days that one hears from practical business men engaged in fruit growing the childish, illogical excuse that they have not "had time" to spray their trees, as these men know well that "spraying trees" and "making money" are almost synonymous terms. There are now to be had free for the asking in Canada publications setting forth the advantages of spraying and giving full instructions as to the best way to prepare and apply simple, cheap and effective remedies for almost any insect or fungous disease that is likely to be found injuring orchard crops. Indeed, to those who have thought upon this subject it may seem unnecessary to again draw attention to this matter in an official report; but in travelling through Canada, notwithstanding the fact that many of the provinces have able and enthusiastic officers who are doing their utmost to teach farmers the great benefits which they may derive from this simple method of protecting their crops, I find that there are thousands of fruit growers everywhere who have never had enterprise enough to follow the advice given. Knowing well, after many years study of this subject, what enormous saving may be made for the whole Dominion through the sure advancement of every individual, I again draw attention to some statements by reliable men, which I trust may have the effect of persuading more of our Canadian fruit growers and farmers that *spraying does most decidedly pay*, and, as far as I have seen, successes follow intelligent, careful and conscientious effort, much more surely in the case of spraying fruit trees than in any other branch of agriculture or of most other walks of life.

"Much loss has heen caused by insect pests. The apple crop in particular suffered much from worms in unsprayed orchards." (*Ontario Crop Report*, Nov., 1898.)

"Wolfville, N.S., Dec, 1898.—Cankerworms have been less abundant this year than usual, but some orchards in Grand Pré and Avonport were stripped. Where spraying was practised, very little damage was done.

"Spraying with Bordeaux mixture and Paris green combined is now generally practised by most of our best fruit growers, both before and after blossoming. They know that it pays them to do so, and is necessary if they are to secure fruit which will bring the highest price. The methods, however, are evidently not as yet thoroughly understood; for some varieties of apples have been somewhat injured in appearance this year, *i. e.*, they are russeted by a too strong solution, or perhaps too frequent applications; but practice and experience will soon give the necessary skill to get the happy medium between over and under dosing."—[R. W. Starr.]

"The day of good crops of fair apples, *without effort*, is for ever gone, unless conditions change greatly, but the prospects were never higher for the pains-taking, thorough orchardist. If any one needs a full, conclusive, and final demonstration that spraying is a necessary part of apple culture, let him look at almost any unsprayed orchard, then compare it with any sprayed orchard which he may find. If he does not see the difference, if he cannot find evidence that spraying has paid 500 to 1,000 per cent, it will be because he is not open for conviction." (Extract from *Report American Pomological Society*, in Nova Scotia *Crop Report* for November, 1898.)

"Victoria, B. C.—Most of the pests and diseases of fruit trees found here have been successfully dealt with by simple remedies which have been recommended through Bulletins and Reports. Enormous advantage has followed the adoption of spraying, and the feeling of uncertainty as to their success which certainly existed at one time in the minds of many of our fruit growers, is gradually being removed. Those who attend to their business properly are, as a rule, well satisfied."—[R. M. Palmer, Provincial Inspector of Fruit Pests.]

In this connection, special attention may be drawn to the series of spraying experiments which have been carried on during the last four years by instruction of the Hon. John Dryden, Provincial Minister of Agriculture and Arts of Ontario. These experiments were at first supervised by Mr. A. H. Pettit, of Grimsby, Ont., and for the last three years by Mr. W. M. Orr, of Fruitland, Ont. A great many orchards in all parts of the province have been sprayed under the personal supervision of the inspector. Fruit growers in the different districts have been invited to be present at these demons-

trations and receive instruction in the way to prepare the materials and apply them. At the last Industrial Fair held at Toronto in September, 1898, one of the most instructive exhibits was undoubtedly the display of fruit taken from sprayed and unsprayed trees in the same orchard. In this collection, which attracted naturally much attention, there were exhibited about 250 plates of fruit from 24 different localities, those from sprayed and unsprayed trees being placed in separately side by side for easy comparison. The fruit was sent in by the owners of the different orchards where the experiments had been carried out, and was not seen by the inspector until they arrived in Toronto, to be arranged and placed on exhibit.

In a most interesting report upon these experiments which was read by Mr. Orr, at the last meeting of the Fruit Growers' Association of Ontario, held at St. Catharines, Ont., in December, he stated that this year he had worked at 30 points covering the province from Amherstburg to Renfrew. The agents visited each point seven times and his dates were announced by poster, postal card and in the press, so that as many as possible might know when these experiments were to be carried on. That the farmers appreciated this effort of the Ontario Government to benefit them and demonstrate to them the best methods of caring for their orchards, is shown by the fact that over 3,500 attended, besides many who visited the orchards at other times when the agents were not there. This is almost double the number who attended two years ago. There was always kept on hand a good supply of the spraying bulletin issued by the Ontario Government which had been revised and brought up to date, and a copy was given to all who wished to receive it. Work was simplified as much as possible, only one solution being used, viz., the ordinary Bordeaux mixture and Paris green, of the strength advised for orchard use: Copper sulphate 4 lbs., fresh lime 4 lbs., and water 40 gallons, Paris green 4 ounces. Notwithstanding the fact that on account of the law which forbids the spraying of fruit trees when in full bloom, and on account of inopportune rains, many applications were lost, as it was necessary to do the work upon the exact dates and at the hours advertised, so that the agent might keep his engagement at the next point he was due at, the results on the whole were most satisfactory, as is clearly indicated by the enthusiasm of some of the orchard owners on whose trees the experiments were carried out. In estimating the percentage of perfect apples, a part of each tree was picked clean and the fruit was carefully examined, every specimen which had a worm or a spot, no matter how small, being rejected as imperfect. This report will be published in full by the Fruit Growers' Association of Ontario, and will contain the reports of the individual owners of the orchards. In concluding his report, Mr. Orr, who is a practical fruit grower, says: "It appears from results obtained in experimental work that from 65 to 80 per cent of perfect fruit can be secured when spraying is regularly and properly done and when the conditions are favourable."

It is perhaps not worth while now devoting more space to this subject; the facts are well known and taken advantage of by all enterprising horticulturists who keep themselves posted on all the subjects which materially affect the profits of their labours. Those who do not know and do not by spraying save every year more than 25 per cent of nearly every crop they grow from the ravages of their many insects and fungous foes, at any rate have not the excuse that they have not had every opportunity of learning.

Every year, as the time for spraying and otherwise treating crop plants comes round, horticultural publications and the weekly and daily press contain articles giving the experience of practical men who have tried these methods and at the same time full advice as to the best way of carrying on the work.

THE APIARY.

I submit herewith Mr. John Fixter's report as manager of the apiary. This branch of the work has been left entirely in Mr. Fixter's hands. It must be attributed to his good management and skill that the bee department this year has become so popular. Meetings of bee-keepers were addressed by Mr. Fixter, at the following places:—Duncanville, Bell's Corners, Merivale, Rockland, and Bearbrook, all in the Ottawa district.

The season for bee-keepers has been a remarkably good one. The clover crop was better than has been seen for many years in Ontario and Quebec, and all shrubs bloomed profusely in early spring.

REPORT OF MR. JOHN FIXTER.

Experiments in Wintering, 1897–98.

The following seven experiments have been tried: Four were tried in the cellar (Nos. 1, 2, 6 and 7), one in a root-house (No. 3), one in a pit dug in a hill side (No. 4), and another in the House Apiary (No. 5).

The cellar is below a private house. The walls are stone and the floor cement. The bee-room, 11 feet 6 inches wide by 15 feet long and 7 feet high, allows three tiers of shelves and two passages. It is boarded off from the remainder of the cellar by a partition which extends all around the chamber, and far enough from the stone wall to allow of a small air space. Under the cement floor a layer of small stones 8 inches thick acts as a drain and keeps the cellar perfectly dry. The lowest shelf is 18 inches from the floor, the second 20 inches in the clear above, and the third 20 inches above that. Neither the hives on the third shelf nor the uprights supporting the shelves touch the ceiling, so that no vibration can reach the hives from the ceiling. This chamber is thoroughly ventilated, also the whole cellar. There is a three inch pipe passing through the bee chamber up to a stove pipe provided with a damper with which to regulate the draught.

Before entering the bee-room is a smaller room with a door leading outside and another leading to the bee-room; both rooms are provided with sliding ventilators, so that outside air may be let in at will. Ventilation is carefully attended to and sudden changes of temperature are avoided; for this, a thermometer which is always kept in the cellar, is watched. The best temperature for the bee cellar has been found to be from 42 to 46 degrees Fahrenheit.

This arrangement has given entire satisfaction. In former years there was not proper ventilation, and the cellar was always damp. Since the concrete floor has been laid and the ventilators put in, the cellar has been much drier and cleaner. It is also rat and mouse proof, which is a very great advantage. The difference in the consumption of honey by the bees is marked, the quantity being now only half what it was before the cellar was improved. The coal stove which was formerly in the smaller room to keep a uniform temperature and to keep the cellar dry, has been abandoned, as the cellar and hives can be managed so as not to require it. I would not recommend any one to use artificial heat.

Experiment No. 1.—Eight colonies were put into winter quarters in the cellar and placed on the shelves. Under the back end of each hive was placed a three-inch block, by which means the back of each hive was raised so as to insure free ventilation. Each hive was besides raised from its own bottom board by a small three-eighths of an inch block placed at the back. All front entrances were left wide open, the wooden covers all removed, and replaced with cushions made of chaff 4 inches thick, and wide and long enough to lap over the hive 2 inches.

Temperature was taken once a week all through the winter:

November, 46 to 47 degrees.
December, 47 to 48 "
January, 44 to 46 "
February, 46 to 50 degrees.
March, 48 "

The bees were quiet, only a very slight hum being noticeable up to February, when, the temperature having risen to 50, the bees began to get uneasy and make considerable hum. Cold air was carefully let in during the night by opening the slides in the doors at night and closing them in the morning; this lowered the temperature and the bees quieted down. During the past winter every colony in this experiment was perfectly dry and clean, and all came out in excellent condition.

Average weight of each hive when put into winter quarters, 53½ pounds; when taken out on 26th March, 44½ pounds per hive, showing that each hive had lost 9 pounds on the average, which is very much less than the usual amount. This small amount is owing to the comfortable cellar. In former years, before this same cellar was arranged as it is, the hives lost on an average 20 pounds, which represented the weight of honey consumed during the winter.

Experiment No. 2.—Two colonies were put into the cellar on 12th November, with tops and bottoms of the hives left on, just as they were brought in from the bee-yard. They were watched for dampness, and to compare the amount of honey consumed. Temperature of cellar the same as in No. 1. During December and January both hives made considerable hum. 27th December, drops of water were noticed all along the entrance of both hives. This same trouble continued in January, when they were both given more ventilation at the bottom by a three-inch block being placed in front between the bottom board and the brood chamber. During February and March both hives got perfectly dry and quiet. 26th March, both hives were removed to their summer stands in fairly good condition; one had spots of fæces on the entrances; both hives were damp and the combs were slightly mouldy, but there were very few dead bees in either hive. Average weight of each hive when put into winter quarters, 62½ pounds; when taken out on 26th March, 48 pounds, showing that each hive had lost 14½ pounds per hive. Another examination was made on 23rd April, when both were found building up rapidly as the season was favourable. 21st May, both in excellent condition for a honey flow.

Experiment No. 3.—Two colonies stored in a root-house. The hives were placed on a shelf nailed up against the wall, about 3 feet from the ceiling and projecting 2 feet. A curtain was hung from the wall over the top and down in front of the hives so as to keep out all light; wooden covers removed and replaced with a chaff cushion. A strip of wood 2 by 2 inches was placed all along both sides between the brood-chamber and the bottom board, so as to give more ventilation at the bottom, both back and front were left wide open. In former years the hives kept in the root-house did not appear to have ventilation enough; this extra space has proved very satisfactory. Temperature was taken every Monday of each week. November, highest temperature, 38, lowest 36; both hives quite dry but very noisy. December, highest temperature, 42, lowest 36; both colonies were very noisy, but were perfectly dry; mice had found their way into both hives and disturbed the bees; some strips of tin put around prevented them getting in again. January, highest temperature, 41, lowest, 39; during January, both hives had drops of water along the entrance and were making considerable sound; no trouble from mice this month. February, temperature 38 to 39, both hives were very much drier, and by the end of the month they were perfectly dry and fairly quiet. March, highest temperature 40, lowest 36, both hives were very noisy and quite damp. 26th March: Both hives removed to bee yard. Both colonies showed signs of dysentery, dampness and mould, but were very strong in numbers.

Average weight of each hive when put in in autumn of 1897, 57 pounds, 12 ounces; spring 1898, 44 pounds, 12 ounces; a loss of 13 pounds. On 23rd April another examination was made. Both hives were building up and in excellent condition for a honey flow.

Experiment No. 4.—November 12. Two colonies were put into a pit dug in the side of a hill, 3 feet deep, 3 feet wide, and 10 feet long, in such a way that the ventilators

at both ends might not be immediately above the hives, which were in the middle of the pit. The hives rested on two cedar poles laid along the full length of the pit. The ventilators, which were 3 inches by 4 inches, were made of boards, three of which reached down to the bottom of the pit, the fourth only to the top of the pit, and the ventilators rose 3 feet above the ground, wooden covers removed and replaced by chaff cushions. In each hive 2 by 2 inch strips of wood were laid under both sides and under the back end between the brood chambers and the bottom boards, so as to provide more space at the bottom of the hive in case a quantity of dead bees should accumulate there. The pit was covered with cedar poles laid along its length, the middle ones higher than the others, and these covered with a layer of straw and one foot of soil. A small shaft was also arranged between the hives, down which a thermometer could be lowered by means of a string, so that the temperature of the pit could be ascertained Temperature was taken once each week. From November to March the temperature did not go below 38 nor above 39. On 26th March the pit was opened, when it was found that water had got in and risen half way up the hives, both colonies appeared to be fairly strong in numbers, combs were badly moulded. On 5th April one hive was noticed to be very weak. On 23rd April it was deserted. The other hive came through well, and on 23rd April was building up rapidly.

This experiment did not come out as well as in former years, owing to the water getting into the pit. This water came from a trench dug above the pit, with no outlet but into the pit. There was no trench dug in former years and no water had troubled.

It will also be noticed no straw was put in the pit over and around the hives as in former years. We find it much better without any straw. Weight of each hive in the autumn of 1897, 62 pounds, and in the spring of 1898, 50 pounds 6 oz., a loss of 11 pounds 10 oz. each.

Experiment No. 5.—Wintering in House Apiary.

Two colonies Nos. 47 and 48, were left in the house apiary with some additional packing. The House Apiary faces the south, the walls are double boarded, with an air space of four inches. The floor, which is about one foot from the ground is also double boarded and there is no draught under it. The hives were moved one foot from the wall, and placed on a double thickness of sacks laid on the floor; the wooden covers were removed and replaced by chaff cushions. In addition to this, the hives were covered above and all around with a double thickness of the same sacking. Also 1 foot of cut straw was put below and all around. A small shaft 1½ inch square extended from the opening of each hive to the outside of the shed; 2 inch strips of wood were placed under both sides and under the back, between the bottom board and the brood chamber, so as to give more space at the bottom of the hive in case a quantity of dead bees should accumulate.

No flying took place from 12th November, 1897, until 7th March, 1898, when several bees flew out but were not seen to return. On 8th March they were flying briskly going out and returning. From 8th March to 26th they flew 9 days.

On 26th March they were unpacked: Hive No. 47 had 2 inches of dead bees on the bottom board and was in a very weak condition. Hive No. 48 also had 1 inch of dead bees on the bottom board but appeared to be in better condition than No. 47.

Another examination was made on 21st April, when hive No. 47 was found to be deserted, the combs were quite dry and clean and there was plenty of sealed honey in the hive.

Hive No. 47 weighed in the autumn of 1897, 54 pounds, and in the following spring 34½ pounds, showing a loss of 19½ pounds. Hive No. 48 weighed in the autumn of 1897, 56 pounds, and in the following spring 39½ pounds, a loss of 16½ pounds.

Experiment No. 6.—Two colonies were put into the cellar with bottoms of the hives left on, just as they were brought in from the bee-yard. The wooden covers were removed and nothing left on except a tightly sealed propolis quilt, the entrance was left wide open. During the entire winter the bees kept perfectly dry, and very slight hum could be heard.

March 26th.—Both hives removed to bee-yard; appeared to be in excellent condition; there were scarcely any dead bees and the hives were dry and clean.

Total weight of the two hives when put in, 104½ pounds; when taken out, 83 pounds, a loss of 10 pounds 12 oz. each. Another examination was made 21st April, when they were both found to be building up rapidly and in excellent condition for a honey flow.

Experiment No. 7.—Two colonies were put in the cellar and placed on the shelves, a three inch block being placed between the bottom board and the brood-chamber only *in front*, making the full entrance 3 inches high across the whole front. The wooden covers were removed and replaced with a chaff cushion. Temperature same as No. 1.

During the whole winter both colonies in this experiment were perfectly dry and clean and showed no uneasiness of any kind. They came out in the spring in excellent condition.

Average weight of each hive when put into winter quarters 58¼ pounds; when taken out on 26th March, 47 pounds 10 ounces, showing that each hive had lost 10 pounds 10 ounces.

Conclusions.

Experiment No. 1.—Has given entire satisfaction for the past four years. The amount of honey consumed during the winters per colony was in 1894-95, 12 pounds 9 ounces; in 1895-96, 10 pounds; in 1896-97, 9 pounds 6 ounces; 1897-98, 9 pounds; or an average for the four years, 10 pounds per colony.

Experiment No. 2.—Hives put in the cellar as they came from the bee-yard had not sufficient ventilation. This result agrees with that of the past three winters.

The amount of honey consumed during three winters was: 1895 to 1896, 13 pounds per colony; 1896 to 1897, 11 pounds 8 ounces; 1897 to 1898, 14 pounds 8 ounces; or an average for the three years of 12 pounds 13⅓ ounces each. Although the amount of honey consumed is not large, the vitality of the bees was not as good as in several of the other experiments tried.

Experiment No. 3.—Wintering in a root-house. This experiment was again fairly satisfactory; although an extra space of 2 inches was given at the bottom, the hives were damp and mouldy. Considering the amount of disturbance the bees are subject to in this experiment, I would consider they came out well.

Once or twice each week the large doors of the root-house were thrown wide open to allow the teams in to draw the roots out, and this let in much cold air which came suddenly upon the hives; also the teams, drawing over the floor, jar them very much. The amount of honey consumed per colony was in 1896-97, 14 pounds, and in 1897-98, 14½ pounds.

Experiment No. 4.—Wintering in a pit dug in a dry hill side. This experiment has been very satisfactory. The past year a misfortune happened; when covering the pit a trench was dug in such a way that water could not run out of it and finally got into the pit. The amount of honey consumed per colony in 1896-97 was 9 pounds, in 1897-98, 11 pounds 10 ounces.

Experiment No. 5.—Wintering in a House Apiary. This experiment was again a failure. The extra packing with 1 foot of cut straw was not sufficient to keep out the cold. I would not advise any one where the temperature reaches 15 below zero to winter in a house apiary such as described in No. 5 experiment.

The amount of honey consumed per colony during the winter of 1896-97 was 15½ pounds, and in 1897-98 16½ pounds. This shows a larger amount consumed; the condition of the bees when taken out in the spring was besides very weak. The colonies either dwindled out or did very little good the following summer.

None of our experiments in wintering out of doors have given the same satisfaction as those in the cellar, even when extra packing was given.

Experiment No. 6.—Hives put in the cellar as they came from the bee-yard, excepting that the wooden covers were removed, leaving on only the thick propolis quilt. This mode of wintering has given satisfaction the past winter but will be tried further.

Experiment No. 7.—Hives in the cellar raised in front only so as to give very wide opening for ventilation. This experiment was also satisfactory and will be further tried.

SEASON OF 1898.

March 9th being a warm, sunny day, twelve colonies were removed from their winter quarters: six were placed in the House Apiary, and the other six in the exposed apiary, where the snow was about eighteen inches deep. All began to fly at once, and the snow soon became very much spotted with fæces, but there were very few dead bees around the entrances of the hives. The hives in the exposed apiary were covered with coarse sacks as a protection, leaving a very small entrance for the bees. In the House Apiary no such protection was given. From 9th to 26th March the bees flew eight days. The remaining colonies were taken out on 26th March.

From 26th March to 9th April the bees flew five days. On 9th April the first pollen was noticed to be gathered. From 9th to 27th April they gathered pollen very freely off soft maple and willows, also off the Manitoba maple. They were seen gathering sap from hard maples, wherever the trees were cut. On 27th April, a very fine and warm day, all colonies were inspected. Any that were found short of stores were fed with warm syrup. For this an empty frame was taken out and held slightly slanting, the syrup was poured on the empty comb until every cell was filled, then the frame was returned to the hive. This plan of feeding answers very well for spring, but not for autumn feeding. The first new honey was noticed on 1st May. Up to 1st May the bees in the house and sheltered apiaries appeared to work better than those in the exposed apiary. On many days when the weather was cool, they were flying well, while none of the others were flying. Those set out early appeared to be in the best condition, as they had several cleansing flights before the others were set out.

May was very fine and warm. The bees worked unusually well, gathering honey and pollen from maples, apple, plum, cherries, Siberian pea-tree, buckthorn, and also from dandelions, buttercups, white and alsike clovers. On 27th May two fine swarms came off; one from the house apiary, and one from the sheltered apiary. Supers were put on all the hives which were full of bees. Many at once began to work in them.

June was very favourable for the bees to work, white and alsike clover being abundant, very much honey was stored in the supers.

July 4th, all supers containing clover honey were removed to a warm room, where the temperature was not lower than 65°. We have found by experience that honey kept in a cool or damp room does not ripen properly. The basswood was just then coming into bloom; the bees gathered considerable honey from it up to 20th July. The supers containing basswood honey were removed on 25 July, as the buckwheat was then beginning to bloom.

On 3rd August when the buckwheat was ploughed under as a fertilizer, the bees had already gathered much honey from it. From 3rd to 18th August the bees were working well on the second growth of alsike and Bokhara clovers. On 18th August all supers were removed, and any honey gathered after that date was left for winter stores. All the colonies were carefully examined at this date to see if they were good and strong, and had a good laying queen. Several were found queenless, and were at once supplied with young queens. It is very important to see that there are no caterpillars of bee-moths around or in the hives. If any traces of moths are noticed these should be cut out at once, and the hives examined at short intervals afterwards.

September 1st to 12th the weather was fine and warm; there was considerable flying. All the hives were weighed, and any that did not weigh over 50 pounds were given full frames of sealed honey. The beginning of September is a good time to inspect winter stores. If syrup has to be fed, the bees will take it down better when the weather is warm, and will thus have a chance to seal it over, which is very important for wintering. But rather than feed syrup to the bees, I would strongly advise every bee-keeper, unless he is thoroughly experienced, to save a few frames of sealed honey in case his bees have not enough to carry them through the winter. He will find it to his advantage to place one or two full frames in the hive in preference to feeding syrup. Feeding syrup to the bees in the autumn gives them a tendency to rob. A good receipt for bee syrup is the following: Boil the water, then remove it from the stove, add at once two parts of granulated sugar to one part of water (by weight) and stir until dis-

solved. It may then be fed to the bees moderately warm in the evening. The old method of dissolving the sugar while the boiler is on the stove is unadvisable as the sugar is liable to be burnt, which would be harmful to the bees.

In order to secure a provision of frames filled with syrup, the best way is to get the strongest colonies to fill and seal them. For this purpose an extracting super is placed on the top of a strong colony, to which syrup is then fed. The bees will then work and fill the frames in the super with syrup. When the frames are filled they are removed and afterwards given to the colonies that require to be fed. If weak colonies were fed in many cases they would be robbed by the stronger ones.

Experiments with Foundations of Different Sizes in the Sections.

There were two objects in view in these experiments. One was to find out which size of foundation the bees would start to work on first; second, to find out which sections would be filled best and have the fewest empty cells around the sections. Several supers were used having the sections so arranged that all would have an equal chance of being filled.

Experiment No. 1: sections with full sheets of foundation fastened on top only. Experiment No. 2: sections with half sheets of foundation fastened on top, and experiment No 3: one inch square of foundation fastened on top in the centre.

In every instance, the bees worked first on the full sheet, and these sections when finished had the fewest holes or empty spaces around them. In the sections which had half sheets of foundation the bees did not work as soon as on the former ones, and the sections were not so well filled. The sections which had one inch square of foundation sheets attached to the top were the last worked on. They also had most vacant spaces around the sections. These experiments should be tried again, also others with pieces of foundation attached at different points around the sections.

House Apiary.

The House Apiary was again tried, and in 1898 to a greater extent than former years. Two tiers of hives have been put in, one on the floor which is one foot from the ground. The second tier was set on a shelf 3 ft. 6 inches from the floor. This plan can be safely recommended for cities or towns where space is scarce, and two tiers can be arranged as well as one in the same building. It has many advantages for the summer, but fails for the winter. See former reports.

Returns.

The past season has been a very good one. The returns of the Central Experimental Farm Apiary for the season of 1898 show an average of 78 sections per colony. The colonies which were run for extracted honey gave 94½ pounds per colony.

Swarming for the season on the whole has been satisfactory. Colonies should not be allowed to give more than one swarm in a season. Excessive swarming may be prevented by the following method: As soon as a colony swarms out and the swarm is well settled, hive it. Remove the hive that it came out of to another stand, then place the new hive on the old stand. Many of the workers returning from the field will help to build up the new colony. If the old colony is found to be still very strong take out two or three frames and shake the bees off in front of the newly hived swarm. This will weaken the old colony and prevent it from swarming again. You will then have a good strong swarm in the best shape for gathering honey.

JOHN FIXTER.

FARM STOCK.

The Horn-fly (*Hæmatobia serrata*, Rob.-Desv.).—In the provinces of Ontario and Quebec the Horn-fly was reported as being slightly more troublesome than last year. This was also the case in some places in Nova Scotia, but at most places the annoyance was less. In Prince Edward Island, where this year it was expected to give more trouble than elsewhere, Father Burke writes from Alberton, P.E.I.: "The Horn-fly was not so bad early in the season as in other years, as the wet weather was fatal to the larvæ, but later it was a troublesome pest and, I feel sure, was as numerous as in its first years here. People did not oil so systematically or persistently, and this may have been the cause. I do not think that any effort is being made to disturb the cattle droppings in the fields where the flies breed."

Remedies.—These consist of applying to the animals some oily substance obnoxious to the flies to prevent them from biting. Of many kinds tried, Mr. Robert Elliot, the Herdsman at the Central Experimental Farm, has for 2 or 3 years used when necessary a mixture of 1 pound of pine tar in 10 pounds of lard, and still finds it the most convenient and effective remedy.

Regularly spreading out the fresh cattle droppings in the field with a rake, so that they dry up and become unfit for the maggots to breed in, has been found an easy and useful remedy. The eggs are laid by the flies at once on fresh droppings, and if these are disturbed every other day in the favourite places in pastures where the cattle congregate, large numbers of the larvæ are destroyed.

AUTHOR'S EDITION

FROM ANNUAL REPORT ON EXPERIMENTAL FARMS FOR THE YEAR 1899

CANADA

DEPARTMENT OF AGRICULTURE

CENTRAL EXPERIMENTAL FARM

REPORT OF THE ENTOMOLOGIST AND BOTANIST

(JAMES FLETCHER, LL.D., F.R.S.C., F.L.S.)

1899

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1900

REPORT

OF THE

ENTOMOLOGIST AND BOTANIST

(JAMES FLETCHER, LL.D., F.L.S., F.R.S.C.)

1899.

DR. WM. SAUNDERS,
Director of Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to hand you herewith a report on some of the more mportant subjects which have been brought officially under my notice during the past ason. There is, as in previous years, and as must always be the case, a vast mount of material accumulating in the Division which cannot be mentioned in the nnual report, but which is frequently of use in answering correspondents and explaining to visitors the work of the Division.

Since the appointment of Mr. Arthur Gibson as a new assistant, in April last, nany specimens have been secured for permanent exhibition in the museum. Exhibiion cases in which the commonest injurious and beneficial insects can be shown have een a great desideratum here, a want which is now being filled as quickly as possible. everal new cases have been secured during the summer, but when the accumulated naterial has been arranged even these will not be sufficient to display all the specimens, nd other cases are now being made.

The experiments in growing grasses and fodder plants have been continued and, as 1 the past, have proved of great interest to all visiting farmers. The Awnless or mooth Brome Grass, which since 1887 I have taken great pains to introduce and istribute through the north-western provinces, still continues to give the greatest satisaction to all who have tried it. It is a heavy producer of excellent fodder and hay, succulent, appears early in spring and lasts late into the autumn. It is a free-grower, riving both on light sandy soils and in rich low bottoms. Owing to its vigour and ee growth, it has been found useful for holding alluvial flats liable to flooding and also a binder of drifting sand. Some two or three years ago a sample of seed was sent to Ir. R. J. Bouteiller, Superintendent of Sable Island, off the coast of Nova Scotia, to hom it has given much satisfaction. He reported on it last year as follows :—'The wnless Brome Grass seed was planted about the 20th May, and I mowed a heavy op in August, much of it headed out. I am much pleased with it and believe it will e a success.' During the past summer Major F. Gourdeau, the Deputy Minister of rine and Fisheries wrote as follows :—'Referring to the Awnless Brome Grass, of ich you supplied seed to Sable Island, I beg to inform you that a letter has been ceived from the Superintendent of the island, in which he states that the plot of this ass is ahead of anything else, and measured on the 27th June between 3 or 4 feet and ore in height, while timothy in just as good ground was a little over half of that.'

Awnless BromeGrass has also given tolerable satisfaction upon alkali patches in e west, succeeding better than all other varieties tried.

Subjects requiring special attention since I last reported were the following :—

THE HESSIAN FLY.—A serious outbreak in Manitoba.

THE ROCKY MOUNTAIN LOCUST.—This insect again appeared in some numbers southern Manitoba, but was not the cause of an appreciable diminution in the crop The exceptionally wet and late season in Manitoba during the past summer wa unfavourable for its early development and spread, and the farmers, having been stirre up to an appreciation of the danger of allowing this insect to remain undisturbe ploughed down the greater part of the stubbles this autumn, thus burying the eggs to deeply for the young to emerge next spring.

THE DESTRUCTIVE PEA APHIS.—One of the most notable outbreaks of the year wa by a plant-louse which has been given the above name but which before this year wa unknown.

ROOT MAGGOTS.—Some experiments against these destructive enemies of th gardener were tried last season with many different substances, but so far without ver satisfactory results. Mixtures containing some form of carbolic acid were most usefu

THE DIAMOND-BACK MOTH (*Plutella cruciferarum*, Zell.).—Late in the autum there was in eastern Ontario a widespread and severe attack upon cabbage of variou kinds, rape, and turnips, by this insect, which has been well known for many years an occasional pest of these plants, and was fully treated of, and figured, in my repo for 1890. In *Farm Insects*, by John Curtis, 1860, the same insect is described a well figured as the Turnip Diamond-back Moth.

THE ASPARAGUS BEETLES.—Two new enemies of the gardener have appeared Canada for the first time this year, the two Asparagus Beetles. These are treated of some length later on.

Fig. 1.—The Forest Tent Caterpillar.

TENT CATERPILLARS.—Orchard and shade trees were again th year seriously injured throughout the greater part of Ontario an Quebec by the caterpillars of the two common species of Tent Cate pillars. Nothing new can be added as to remedies; these consist the collection of eggs in winter, the destruction of the nests an clusters of young caterpillars in spring, and last, but most importan the spraying of trees with poisonous mixtures as soon as possible aft the hatching of the eggs. The last operation, when performed car fully, is a never-failing remedy.

BARK-LICE.—The San José Scale and several other allied speci of scale-insects have naturally been the subject of much correspon ence. Thorough experiments are now being carried out by specialis in all parts of North America with the hope of discovering a practic remedy. Several materials have given good results which with ordi ary insects might be considered all-sufficient remedies, but with t San José Scale it seems inadvisable to recommend under the existi laws which have been passed by the Federal Government and those of Ontario an British Columbia that fruit growers themselves, should be allowed to treat their tre with any of the materials which, up to the present, have been claimed to be 's remedies,' such as pure kerosene, the same mechanically mixed with water, and c petroleum.

THE APRICOT SCALE (*Lecanium armeniacum*, Craw).—Another scale insect fr California, which in some way has been introduced into the Eastern States, and spreading there to some extent, has been found in two or three orchards at Sh brooke, Que.

THE RASPBERRY WEB-WORM.—A local but interesting attack by a new enemy to cultivated raspberries was reported from St. John, N.B., last year, and has been worked up during the past season.

THE CRANBERRY LOOPER (*Caterva catenaria*, Cram.).—A new attack of some severity upon strawberries was by the common 'Cranberry Worm,' which was reported by Mr. George Bonner, of Point Aconi, Cape Breton, N.S.

THE PEA MOTH (*Semasia nigricana*, Steph.) is still much complained of, particularly in the Maritime Provinces, as shown by the following letter :—

'CLIFTON (King's Co.), N.B., December 19.—I have not made any recorded observations, but think this insect was not quite so destructive last season as usual. It has, however, come to be such a matter of course with us, that we take its ravages quite philosophically and pick the caterpillars out of our peas for the table ; when too bad, we throw the whole mess to the pigs or cows. This insect has been injurious here for a period beyond my recollection, some 50 years.'—J. W. WETMORE.

THE CARROT RUST-FLY (*Psila rosæ*, Fab.) continues to be a troublesome pest of carrots in the province of New Brunswick. Mr. J. E. Wetmore, of Clifton, N.B., writes :—'Of late years we have about abandoned the culture of the tender varieties on account of its depredations. It does not trouble the hardier varieties here apparently, for we can get full crops of the white carrots when the orange ones are a complete failure in the same field.'

In Prince Edward Island, Father Burke reports widespread injury by plant-lice upon carrots.

THE SPRUCE GALL-LOUSE (*Chermes abietis*, Linn.)—A cause of considerable inquiry and anxiety among those interested in the manufacture of paper during the past year or two has been the Spruce Gall-louse. This insect is prevalent through a large part of Ontario, attacking the Black and Norway Spruces. In the Rocky Mountains, galls probably made by a different species were noticed in abundance on White Spruces at Banff, Alberta, and, on Vancouver Island, trees of the Menzies Spruce (*Picea sitchensis*, Carr.) in certain places in the forests, were much disfigured by another species of Chermes, probably *C. sibirica*, Cholodk., which forms large galls, sometimes two inches in length by nearly one in diameter. These were not found at all on the Douglas Spruce.

THE BLACK VIOLET APHIS.—An infestation of greenhouses not previously complained of in Canada by the above insect occurred in Toronto, and is treated of later in this report.

THE GREENHOUSE LEAF-TYER is also a new pest treated of hereafter.

THE CARPET BEETLE OR 'BUFFALO MOTH' (*Anthrenus scrophulariæ*, Linn.).—This troublesome pest of the housekeeper seems to be spreading and becoming more destructive year by year. During last spring a few specimens were taken out of doors at Ottawa on the flowers of Currants and Spiræas. Beetles were also sent from Bewdley (Northumberland Co, Ont.) which had been found by Mr. T. W. Ramm, in the folds of a cloth left hanging in an apple tree during winter.

Correspondence.—From November 30, 1898, to November 30, 1899, the number of letters received by the Division was 2,495, and of letters sent 2,320.

Meetings attended.—Meetings of farmers, dairymen and fruit growers have been attended at the following places :—January 10 and 11, at Kingston ; 27, at St. Catharines, February 3, at Hemmingford, Que. ; 10, at North Gower, Ont. ; March 10, at Merivale, Ont.,

17, at Montreal ; April 3, at Napanee, Ont. ; 4, Brampton ; 5, Oakville ; 6, Hamilton ; St. Catharines ; and three series of meetings in Manitoba, the North-west Territori and British Columbia are reported on at the end of this report.

Acknowledgments.—As in previous years, I am under great obligations to ma correspondents, to practical farmers, who have much aided the work of the Division making observations and sending in prompt reports on the occurrence of injurio insects and weeds, and to scientific experts in Canada and abroad. I must particular mention in this connection Prof. John Macoun, of Ottawa, for assistance on ma occasions, and also Dr. L. O. Howard, United States Entomologist, of Washington, D.(and Dr. J. B. Smith, of New Brunswick, N.J., for frequent assistance in the identi cation of insects and for the use of electrotypes and magic lantern slides.

In conclusion I have much pleasure in expressing my appreciation of the enlarg opportunities for doing good work in the Division entrusted to my care, which ha been granted me during the past year.

Mr. Arthur Gibson, of Toronto, was appointed as an extra assistant on April last, and has shown great assiduity and care in all matters entrusted to him. Mr. A. Guignard, B.A., the Assistant Entomologist and Botanist, continues to help me in branches of the work of the Division, and as heretofore has done much to bring t Division of Entomology and Botany to such degree of efficiency as it has attained.

I have the honour to be, sir,

Your obedient servant,

JAMES FLETCHER,

Entomologist and Botanist.

CEREAL CROPS.

Complaints of injury to the wheat crop by insects during 1899 were few, with the exception of a new and severe outbreak of the Hessian Fly in Manitoba, a rather serious occurrence of the same insect in Western Ontario, and a slight one in Prince Edward Island.

In the November *Crop Report* (Ontario Bureau of Industries) it is stated:—'There has been a notable absence of insect pests. There are few complaints of insect pests except that Hessian Fly, Jointworm and Wireworm have done some damage.' 'Alberton, P.E.I., October 31.—Seldom has Prince Edward Island garnered a more satisfactory all round harvest than this year. Hay is bursting the mows, the granaries are filled with golden grain, and although in some sections potatoes are not an average crop, on the whole, we rejoice in an excellent yield of roots.'—REVD. A. E. BURKE.

'Pleasant Grove, P.E.I.—The wheat crop on the whole is a good one; some fields were damaged by what we call 'black neck,' said by some to be the rust. Attacks by the Hessian Fly were not common, a few plants being injured, but we have had a considerable quantity of Wheat Midge on the Island this year.'—E. WYATT.

Barley was slightly injured by Hessian Fly in Manitoba, and oats and corn in Ontario to some extent by grasshoppers. The two most serious outbreaks of the season upon cereals were by Hessian Fly in Manitoba and in Western Ontario, and by a new enemy of the pea, the Destructive Pea Aphis, which did great damage to field peas from the Maritime Provinces to Western Ontario in Canada, and extended right down to the Southern States in the Union. That old enemy, the Pea Weevil, was also more than usually destructive and abundant during the season of 1899.

THE HESSIAN FLY

(*Cecidomyia destructor*, Say).

Fig. 2.—The Hessian Fly—enlarged and natural size.

Complaints of injury by the Hessian Fly during the past season were numerous to fall wheat in Ontario and to spring wheat in Manitoba. Wheat was injured in many parts of Manitoba, but chiefly in the Red River valley. The most western occurrence reported to me (with specimens) was from Moose Jaw, in the North-west Territories. At the request of some of my correspondents for public advice as to the best means of preventing future loss, articles were prepared for publication in the *Farmer's Advocate* (September 15) and the *North-west Farmer* (September 20), both excellent agricultural journals, widely circulated and read by farmers, in which the chief points in the life history of the insect were given and suggestions made as to the best known remedies.

The following extracts from some of the large correspondence on the matter will show the extent and nature of the outbreak. The first reports and specimens from Manitoba were received from Mr. Hugh McKellar, Chief Clerk of the Provincial Department of Agriculture.

'Delmer (Norfolk Co.), Ont., August 8.—In view of the immense damage done by the Hessian Fly to the wheat crop in this and in many other localities throughout the

province, farmers are very much interested in the matter and would like to know some thing of the habits of this insect—whether it is likely to assert itself in next year's crop whether the discontinuance of wheat growing for a season would be necessary to exter minate it, or whether such omission would be of any value in eliminating the pest, &c. &c. Any information you could give us would be very gratefully received, especiall at this juncture—the eve of another seeding.'

'Delmer, September 13.—In South Oxford the fly was very injurious, destroyin fully one-half of the fall wheat remaining, after an unusually severe 'winter killing'— there was scarely a wheat field that was not injured more or less; the earlier sow suffered most. In North Oxford damage was much less, in West Brant, also much less ditto in West Norfolk, in East Elgin middling severe, quite severe in East Middlesex and again, in North and West Middlesex not so severe.'—CHAS. BRADBURN.

'Winnipeg Man., August 26.—Herewith I am sending you specimens of an insec that has done considerable damage on the farm of Mr. James Little, Stonewall. The speci mens were forwarded by Mr. Ira Stratton, of Stonewall, who says that about one quarter of Mr. Little's wheat has been cut down by these insects. Would you kindl let us have any information at your command regarding this pest, and what measure should be adopted to prevent its recurrence next year?'—HUGH MCKELLAR, *Chie Clerk, Dept. Agriculture.*

'Macdonald, Man., August 26.—I notice since starting to cut my wheat tha quite a lot of the straw is broken just above the second joint, although the heads seem to be well filled; of course the sap is not altogether stopped as the straw is not broke completely off. I find on examining it that there is a single maggot or worm in brown shell, between the leaf and stem just above the joint, that has caused the injury Can you tell me what it is and if it is likely to be worse another year? There is from to 7 or 8 per cent of the straw affected with it.'—HENRY KIRKWOOD.

'Portage la Prairie. Man., August 28.—Inclosed find wheat joints which I hav cut from my field. The wheat is bent down just above the joint. I find by openin the straw that there is an insect on the upper side of the joint. The grain in the hea appears to be all right, but the straw and head are not as large as the balance that i standing. My heavy wheat does not appear to have been affected. Would you kindl let me know through the *Nor-west Farmer* what it is, as I presume there are othe fields throughout the province affected the same way?'—CHAS. CUTHBERT.

'Winnipeg, August 29.—At several points throughout the province I hav noticed this year in the wheat fields that a greater or less proportion of the straw appear to break about the first joint from the ground, and, where this is very bad, it give almost the appearance of their having been broken down by hail, except that most of th straws seem to lean in one direction as though they had gone down under pressure o high winds from one quarter. I am told by some parties that a little worm about of an inch long is found in the straw, at the first joint. The appearance of the hea is entirely different from what we call "dead heads" as the grain is maturing in th heads, some of them still being comparatively green, although I think in every cas the grain will be shrivelled, and the heads seem to be shorter and smaller than th average heads in the field. I saw two fields of this out at Melita a little while ago, an yesterday at Otterburn saw a great deal of it, and I understand from the farmers a Emerson, that it is very prevalent throughout that district. I was also speaking to man from Plum Coulee, who told me he had to set his binder much lower than usual i order to avoid cutting off the heads that were broken down, and I am inclined to think that this trouble, whatever it is, is very prevalent throughout southern Manitoba.'

"Winnipeg, Oct. 11.—I fancy the damage done by the Hessian Fly has bee pretty serious in some localities, but, as people were not acquainted with the insect o were not looking for it, not many noticed it; perhaps, too, they attributed the shorta to a wrong cause. I understand that its attacks were very bad in the Stonewal Carman and Niverville districts."—G. H. GREIG, of *The Farmer's Advocate.*

'Winnipeg, Oct. 3.—In response to your request for information on the Hessia Fly in this province, by Mr. McKellar's instructions, I made an excursion to Stonewa on Friday and Saturday last. There is no doubt whatever that the fly is all throug

the wheat-growing country around Stonewall and Balmoral—every farm I inspected had it. I found puparia in every wheat and barley field I entered, and in every stack of unthreshed wheat looked at. I was able to examine the screenings from one threshing place (on the farm of Mr. J. Little) and here there were puparia in abundance. The first place visited was the farm of Mr. J. McEwen, where there was a piece of breaking very bad with the fly. Mr. McEwen estimates the damage at one-third of the crop, and I am sure the estimate is a careful one. The next place visited was Mr. Jas. Little's. It was from this farm that the specimens were sent to you last month. The damage here was quite as great as on the last place, but in this case the land bore a crop of wheat last year. It was on this farm that I examined the screenings from the thresher. Mr. Martin Shepley estimates the damage done to his summer fallow at one-fourth or perhaps as much as one-third. I have mentioned these three farms because they are the only cases in which I was able to see the farmers and discuss the question with them. As to barley I could secure no estimate of the damage done. No barley had been threshed, and there is not the same interest in the barley crop as in wheat. I did not find the puparia so numerous in barley fields as in wheat fields. The puparia were almost invariably above the second joint, usually singly, though sometimes in twos and threes. I collected a number of specimens of which I send you a few in case you wish to breed the parasites.

'Summer-fallow and breaking suffered quite as badly and as generally as land cropped last year. Fallow and breaking are naturally the earliest sown, as they are soonest in condition for seeding. The weather during seeding was very cold and backward, and continued so up to the 10th June, after which the most perfect conditions for growth prevailed. I may also quote the statement of Mr. J. Little that the wheat which was earliest cut was less broken down than that cut later. In reply to a further question, he said he did not know whether it was less *damaged*, but it was certainly less broken down. Mr. J. McEwen stated that greener portions of a field were less broken down than riper ones. From this I would point out that the amount of damage was estimated generally from the state of the crop before threshing, that green or underripe grain does not break off so readily, and that a crop cut a shade green would not show the full amount of damage done.'—MELVIN BARTLETT, *Dept. Agriculture.*

'Buffalo Lake, Moose Jaw, Assa., Aug. 30.—When I wrote you some three or four weeks ago with regard to the wheat pest, I had not observed any indications of it. Since then it has become quite evident. I learn from a neighbour adjoining me that he had it last year. At present there are quite a number of heads through my crop and a very considerable number in my near neighbour's. It seems especially bad on the outside of the field; where he was cutting wheat 2 or 3 days ago, the outside 10 or 15 feet was very materially damaged. It seemed to attack the maturer heads, not troubling the greener grain much.'—G. S. TUXFORD.

'Emerson, Man., Sept. 1.—I am enclosing to you some samples of wheat straws injured by the insect referred to you some days ago by Mr. Geo Greig of the *Farmer's Advocate*, Winnipeg. You will find them located immediately above the joint first from the ground. Kindly examine and let us know the name, and likelihood of recurrence another year, remedy if any, and any information you deem of use. This pest is more or less found all over the province, and is estimated to have done as much damage in some places as to reduce the yield 20 per cent.'—W. W. FRASER.

'Winnipeg, Sept 1.—We enclose sample of straw from Winkler Station, where it has drawn attention. Is it the Hessian Fly?'—RICHARD WAUGH, *The Nor-West Farmer.*

'Winnipeg, Sept. 1.—Enclosed find a few stems of wheat straw cut at ground and fallen in crop so as to be missed by the binder. In each straw is an insect, the cause of fall. About one in a hundred of the stems was so affected. What is it and how can it be treated?'

'Holland, Man., October 4.—In every field I have looked (that is in Manitoba), I have found traces of the Hessian Fly. I know of no other insect doing the farmers any injury this season.'—F. D. BLAKELY, of *The Nor-West Farmer.*

'Balmoral, Man.—I am sending you under separate cover an insect in pieces of wheat straw. It is found at the joint nearest the ground. Just above this joint

it eats its way through the stalk and escapes. The straw bends or breaks at this place, leaving the straw as if fowls had pulled it down. One man told me his wheat would not be more than half a crop owing to the work of this insect. Would you kindly let me know what it is? It was not noticed until cutting commenced'.—R. W. NEILL, M.D.

'Pilot Mound, Man.—A considerable quantity of the wheat is breaking down badly at the second joint. I was attributing the cause to the straw being weak, owing to rust and showery weather making it softer than usual. I have examined some of the broken straws and found one containing a chrysalis, which I enclose. I hope the western wheat fields are not going to be troubled with weevil or any kindred pest. The wheat crop in this district is practically all in stook. Several were thinking that it is always better to begin on the green side as a very severe wind storm seemed to have broken the straw down.'—D. A. STEWART.

'Portage la Prairie, Man.—As to the extent of the damage by the Hessian Fly, it is very uncertain, some districts were more seriously affected than others. We had several light hailstorms here and there, and many farmers thought they were slightly damaged, but I now think that the damage was caused by the Hessian Fly. I find that the yield is not up to the expectations of the farmers, more especially in the older districts, and I am convinced that it was the Hessian Fly that reduced the yield. But we have been blessed with the most uniform good crop I have ever seen in the province, and hence the slight damage done is not seriously felt. The weather has been, and is yet, simply grand. I found in gathering these specimens I send, that they were more plentiful in late grain than in earlier, also the last heads to come out were the most affected.'—CHARLES BRAITHWAITE.

As stated above, last season is the first in which the Hessian Fly is known to have done harm to crops in Manitoba, and many farmers did not recognize the insect until the matter was brought before them by discussion in the daily journals and agricultural press. With a view to gathering as much information as possible about the occurrence and extent of injury, a series of questions was submitted by the *Farmer's Advocate* to its readers, and answers were received from many of them. Some of these answers were published in the issue of December 5, from which it would appear that the loss, according to locality, was from 5 to 25 per cent of the crop, and that the attack was general, irrespective of the nature and condition of the soil, or the time of seeding. Nevertheless farmers in different localities held strong opinions that there were decided differences, some stating that early sown grain was exempt from attack, while others thought the opposite. Mr. W. R. Graham, Superintendent of the Stony Mountain Penitentiary farm, Manitoba, stated to me on October 4, 1899, that the Hessian Fly did not attack his early sown wheat at all, and he thought this was general throughout his neighbourhood, that in 1899 early sown wheat was much less attacked than that which was sown late and held back by the late season.

In answer to the questions in the *Farmer's Advocate*, Mr. R. W. Greig, of Otterburn, reports that late-growing grain suffered most, although, in some cases, that which was sown very early was injured more than some of that which was put in late. Mr. H. O. Ayearst, St. Paul's municipality, reports wheat on new land as 'badly damaged, at least 25 per cent of the crop; no injury on old land, new land only being injured.' On the other hand, Mr. S. R. Henderson, of Kildonan, reports it to have been 'worst on old land that had been summer-fallowed, with surface cultivation in the spring, and sown early.' Mr. Robert Fisher, of Springfield, says: 'I could see no difference on old land or new, fallow or stubble, fall or spring ploughing, or in early or late sowing, though none of our sowing was very early. My own crop was seriously injured by the fly, 8 to 18 per cent of the whole crop being destroyed.'

The extent of injury was doubtless due to the condition of the wheat plant at the time the females were laying their eggs. The injury by the maggots of the summer brood is, as a rule, at the lowest joints of the stems, and, as upon hatching the young maggots work their way down to the base of the leaf upon which the eggs were laid, it would indicate that the plants which showed injury were those of which the stems were just shooting up at the time the eggs were laid. At the same time, it must be remem-

bered that there is on spring wheat in spring an early attack at the roots similar to that on fall wheat in autumn, by which very large numbers of wheat plants are destroyed without making stems at all. This attack is, as a rule, not noticed by farmers, because the plants which are left living, stool out more and fill up the gaps.

In a field which I had under constant observation during the summer of 1890, many plants were entirely killed by the spring attack, and others bore only a single weakly stem, most of the shoots having been destroyed; but, from the stooling of the uninjured plants, the general appearance of the field was that of a fair crop, and none of the straws could be found containing puparia, showing that all the eggs were laid before the plants began to shoot. Without close observation this attack would have been overlooked and would not, in all likelihood, have been noticed by farmers. Nevertheless the puparia of the insects which had done the harm, were still in the fields to emerge later and carry on the injury. This same state of affairs may have been the case in Manitoba last year, and much injury then done which was unnoticed. Although not detected, the Hessian Fly must certainly have been present in Manitoba in considerable numbers last year for eggs to have been laid over such a wide area. I have no doubt from an examination of specimens collected in various parts of Manitoba last autumn, that in that province there is only one brood of the Hessian Fly. This insect confines itself in a remarkable degree to the wheat plant, and, although barley and rye are occasionally attacked, this is exceptional; the very rare occurrence of pupæ in timothy, which has been recorded, must be regarded as quite accidental. No fall grain of any kind is grown in Manitoba, and puparia formed in the straws last summer still (December 30, 1899) contain living larvæ in good condition.

Prof. F. M. Webster, the author of most valuable studies on wheat pests, has maintained for many years that the Hessian Fly would be found to be single-brooded when a point sufficiently far north or south of its metropolis, or centre of distribution, was reached, the extremes either of cold or heat preventing the production of food in suitable condition for the second brood, the summer brood instead of emerging in autumn hibernating as flax seeds in the north and in the south remaining in a quiescent condition (æstivating) as flax-seeds during the hot dry period of the protracted southern summer.

This theory of the insect's power to adapt itself to varying conditions was explicitly set forth by Prof. Webster in Ohio Bulletin No. 51, 1893, and as late as March last the same author writes:—'As you know, I have always questioned the occurrence of a second brood of Hessian Fly so far north as North Dakota, but I have never had an opportunity to substantiate my position. I had hoped that you might settle this Hessian Fly problem, and put the question to rest once for all with respect to the number of broods. The insect certainly occurs in areas where there is no fall wheat, but an abundance of spring wheat, and it does not seem to me possible that it could survive in such localities if it were double-brooded, as there is nothing on which a fall brood could winter over, except the spring wheat stubble.'

The importance of exact knowledge as to the number of broods is seen to be very great when we come to a consideration of remedies. The severity of the attack during the past season and the interest which has been created in the subject, through the agricultural journals, added to the fact that the weather has been most propitious this year for autumn work, have induced farmers to make themselves acquainted with the natural history of the Hessian Fly, and to adopt the methods which experience has shown are the best: namely, to burn over the stubble when possible before ploughing, and, at any rate, to plough down deeply all stubble this autumn or before the season for the flies to appear next spring.

As Mr. Greig has stated in the *Farmer's Advocate* for October 20:—'Whether or not the stubble is burned off, the land should be carefully ploughed. Even with no Hessian Fly, careful ploughing is really one of the great essentials to a successful crop. The work cannot be too well done. Not only does good ploughing leave the land in better shape and kill more weeds, but it greatly reduces the amount of harrowing and after work necessary to get the land into the best condition for the seed; and no doubt grain that comes away vigorously and early, and makes rapid growth, has more chances of escaping this or any other pest.'

The following article was published in the *Farmers' Advocate* for September 15, 1899, and similar articles were prepared for the *Nor-West Farmer* and other Manitoban papers:—

THE HESSIAN FLY.

During the past season rather extensive injury has been wrought by that old-time enemy of the wheat-grower, the Hessian Fly. From Western Ontario comes intelligence of the worst attack upon fall wheat, and the question is asked by some farmers there, whether it would not be well to discontinue altogether for a season the cultivation of fall wheat. The most serious injury and the attack of by far the greatest importance as pointing to future possibilities of loss from the Hessian Fly is reported from the Province of Manitoba, by Mr. George H. Greig, the Manitoba editor of the *Farmer's Advocate.* Inquiries and specimens have been received from almost all parts of the province, and from as far west as Moose Jaw in the Territories. Correspondents estimate the loss at between 5 and 20 per cent. This, of course, is all in spring wheat, as in the west no grain is sown in the autumn.

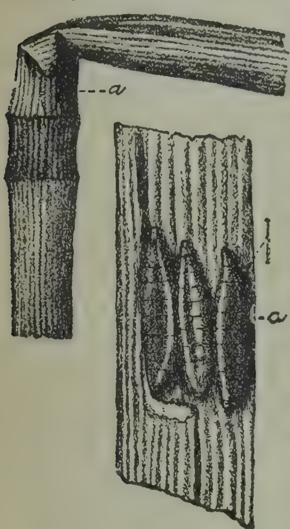

Fig. 3.—Hessian Fly: injured wheat-stem; three puparia enlarged.

The life history of the Hessian Fly is well known. The effects of the injurious work of the maggots on fall wheat can be recognized in the spring of the year by one or more dead shoots or whole plants in wheat fields. Upon examining these plants the characteristic pupa-cases, which resemble closely small elongated flax seeds, may be found in the crowns of the injured plants. Sometimes three or four specimens will occur beneath the leaf-sheaths of a single shoot. The flies from this brood emerge in the spring and lay their eggs upon the leaves of the shooting grain, and later, as at the present time in Manitoba, the same flax-seed-like pupa-cases described above and shown at Fig. 3 may be found above (as a rule, but occasionally higher), the first or second joints of the stems of barley, rye and wheat, where they lie between the base of the leaf-sheath and the stem, somewhat sunk in the tissues, so as to give the appearance of being actually inside the stem. During their growth the maggots have lived at the expense of the wheat plant, sucking the sap, so that the stems are weakened and frequently fall down, bending over just above the point of attack. This is well shown at Fig. 3*a*, and by it the presence of this enemy will probably be recognized by many Manitoba farmers who may have overlooked it in their crop. In Manitoba, it is most probably the case that there is only one brood of the Hessian Fly in the year, the winter being passed in the 'flax-seed' condition, for the most part in the stubble, but also to some extent in the straw which was harvested. Further south than Manitoba there are two distinct broods.

The perfect insect, a tiny blackish gnat, not expanding more than a quarter of an inch from tip to tip of its wings, appears in May and June and lays its eggs, which produce the summer stem-attacking brood. In Manitoba the flies from this brood do not emerge until the following spring, but in Ontario they appear in August and until about the middle of September, and the females lay their minute scarlet eggs upon the inside crease of the leaves of early-sown fall wheat. The young maggots, upon hatching, work their way down to the axils of the leaves, where the injury to the plant is done. Most of these maggots become full grown before winter sets in, and assume the 'flax-seed' condition.

Remedies—1. Late sowing.—With regard to fall wheat, the postponement of seeding until after the third week in September delays the appearance of the young plants above the ground until all the egg-laying flies of the second brood are dead. In cases where fall wheat has been sown in August and is already well up, it will be well this year, in such localities as the Hessian Fly is known to have been present, to feed off the young grain with sheep. In this way many of the eggs, it is claimed, are eaten with the leaves of the wheat. Care must be taken that the fields are not cropped too closely or too late in the season.

2. Burning refuse.—Many of the 'flax-seeds' of the summer brood are carried with the straw, and at threshing are dislodged and thrown down beneath the machine,

among the rubbish, or are left in the straw. All screenings and dust should therefore be destroyed carefully, and all straw should be either used during the winter or burnt before spring.

3. Fertilizers.—When it is known that a young crop of fall wheat has been injured by the Hessian Fly, it is a good plan to apply, the following spring, a light dressing of some quick-acting special fertilizer in order to invigorate the plants.

4. Treatment of stubble.—As the Hessian Fly is undoubtedly restricted in Manitoba to the summer straw-attacking brood, the remedy is simple, and, if persisted in, I cannot think that the Hessian Fly need ever become a serious menace to western wheat-growers. The insects passing the winter for the most part in the stubble and not appearing until the following spring, when there are growing wheat plants for the females to lay their eggs upon, if the stubble be burnt over or plowed down in autumn and the straw fed to stock or burnt at any time before the flies emerge in the spring, this dire enemy of the wheat-grower should be easily controlled.

It was to be expected, as stated in my last annual report (*Exp. Farm Report*, 1898, p. 174), that at no very distant date we might have trouble from the Hessian Fly in our western wheat fields, for Prof. Lugger has recorded that in the Red River valley, in Minnesota, where the conditions are similar to those of a large part of Manitoba, a large area of that state was infested in 1896, the damage in some places amounting to more than 25 per cent, and that on an average the farmers lost from 5 to 10 per cent of their entire wheat crop.—J. FLETCHER.

Fig. 4.—Hessian Fly: puparium containing six cocoons of *Polygnotus hiemalis*—enlarged.

Fig. 5.—*Bæotomus destructor*, female—enlarged.

One of the chief reasons why the Hessian Fly has not been very injurious in Minnesota since 1896 is, Prof. Lugger thinks, the abundance of parasites which appeared in 1897. A few of these friends of the farmer (*Polygnotus hiemalis*, Forbes) have been found in infested straws sent to me by Mr. W. W. Fraser from Emerson, Man. Three specimens of the most important parasite of the Hessian Fly, *Bæotomus* (*Merisus*) *destructor*, Say, were bred by Professor Lugger from straws sent to him by Mr. Chas. Braithwaite from Portage la Prairie. It is to be hoped that these parasites will increase largely in numbers. Unfortunately, however, Professor Lugger writes under date October 20, that in Minnesota 'Parasites of the Hessian Fly, are decidedly scarce this year. From 40 different places (about 75 infested straws from each) I have raised less than 25 parasites. Nearly all of them came from straw obtained from near Crookston, Polk Co., Minn. South of that place I have found none, north but a few.' Manitoba material received from Mr. Braithwaite contained three specimens of the females of *Bæotomus destructor*. On the other hand, in Prince Edward Island a much more satisfactory state of affairs may be reported; for, from a packet of infested straws from Mr. Wyatt received during 1898, no less than five different kinds of parasites were reared, viz:—*Bæotomus destructor*, *Eupelmus Allynii*, French, *Eupelmus*, n. sp., *Tetrastichus productus*, Riley, and *Entedon*, possibly *E. metallicus*, Nees. Cuts 3, 4, 5 & 6, used here have been kindly lent by

Fig. 6.—*Eupelmus Allynii*, male—enlarged.

No

Prof. Lugger. Reports from Prince Edward Island this year mention serious injury by Hessian Fly ; this is most probably owing to the increase in the numbers of these parasitic species.

THE DESTRUCTIVE PEA APHIS

(*Nectarophora destructor*, Jnsn.).

Attack.—Pale green plant-lice with legs darkened, particularly at the joints, honey tubes very long ; clustered in enormous numbers at the tips of the shoots, beneath the leaves, and sometimes over the whole plants of field peas, as well as upon the flowering Sweet Peas. These insects appear suddenly in large numbers and very soon kill the plants by sucking their sap. The winged specimens are rather large for aphides, being about one-eighth of an inch in length, with a wing expanse of nearly one-quarter of an inch.

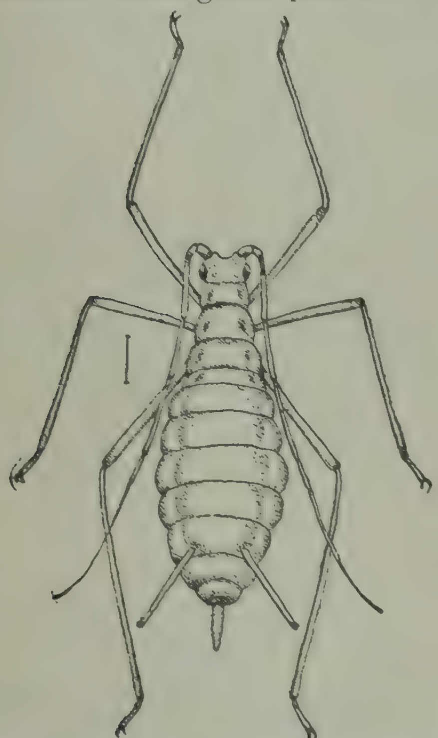

Fig. 7.—The Destructive Pea Aphis : wingless viviparous female—enlarged.

One of the most remarkable outbreaks of the year, which extended over a very wide area, was by a previously undescribed species of plant-louse. This was reported from various places in Canada from the Maritime Provinces to Western Ontario, even extending up into the sparsely settled country in the Nipissing District. It also occurred in destructive numbers in many parts of the United States ; Prof. Johnson, of Maryland, the describer of the species, who read a paper on the subject at the last meeting of the Association of Economic Entomologists, says:—

Fig. 8.—The Destructive Pea Aphis : winged viviparous female—enlarged.
(Figs. 7 and 8, after Johnson, Md. Agr. Exp. Sta. Bul. 63.)

'Pea growers nearly everywhere along the Atlantic coast consider that they have been visited by a veritable scourge. The attack has not been confined to Maryland alone, but I have records of the occurrence of the pea-louse in Delaware, New Jersey, New York (Long Island), Pennsylvania, Virginia, North Carolina and Connecticut.

'The growing of peas in Maryland is a very important industry, and reliable conservative authorities place the loss this season at $3,000,000, the principal cause being the pea-louse. In many cases the destruction was complete, varying from mere garden patches to hundreds of acres.'

The Destructive Pea Aphis appeared in alarming numbers in the United States this year much earlier in the season than was the case in Canada, and consequently the loss to pea growers was greater, because in Canadian fields the seeds inside the pods in some instances had become fully formed before the Aphis appeared. By the end of May in Maryland many acres of peas were already destroyed, but in Canada it was not until the very end of July that the first complaints of injury began to be received.

The following extracts from some of the letters of correspondents will give an idea of the suddenness with which this insect appeared and the extent of its injuries :—

'Alberton, P.E.I., Oct. 31.—It appeared as if nature had striven this year to multiply aphides to infest every kind of plant. All the fruit trees were infested, the whole range of garden truck had its load, and out in the fields they so mutiplied on peas sown without grain as to flatten vigorous crops to the ground and completely ruin them. The rain prevented the kerosene emulsion from doing its work.'—REV. A. E. BURKE.

'New Minas (Kings Co.), N.S., July 29.—I observed to-day when walking through my peas, that there were swarms of active flies somewhat resembling house flies, only very shiny. (These were evidently Syrphus flies, the larvæ of which do such good service by feeding upon plant-lice, as stated further on.—J.F.) On looking closely, I found that the vines, including the young pods, were all covered with creeping insects. I send you some of these, and shall be glad to know anything you can tell me about them, for I fear that they will destroy the crop.'—BUDD BISHOP.

'Nappan (Cumberland Co.), N.S., August 8.—I send you samples of the work of the insect which is destroying our peas. I am very much afraid that it is going to ruin completely our experimental pea plots. These insects increase and spread with amazing rapidity. On Aug. 2, I went carefully over all the pea plots and noticed that there were a few of these insects distributed all over them. By the 6th they were in great numbers in spots all over the field, and now, two days later, they cover the whole vines, so that the whole crop will surely be ruined. The lice cluster upon, and completely hide the tender parts of the stalk, the blossoms and the under surfaces of the leaves. On account of their being mostly on the undersides of the leaves, it is hard to get at them with any kind of spray. This aphis seems to be very much like the one we sometimes have on plum trees, but it is now much more numerous than anything I have ever seen on plum trees, for these literally cover the whole field and they only take about 10 days from the time they first appear to suck the life out of the plants and leave white dead stalks. I am afraid this is a very serious matter for our pea crop.'—R. ROBERTSON, *Superintendent Expt'l Farm.*

Later in the season Mr. Robertson wrote under date of Dec. 15 : 'The worst insect of the year with us was the Pea Aphis which was not only extremely abundant and destructive on our own farm ; but judging from the number of inquiries by visitors at Nappan, about what was termed in a general way 'the blight,' it must have been very prevalent in many parts of New Brunswick and Nova Scotia.'

'Adamsville (Kent Co.), N.B., Aug. 18.—I send you herewith a stalk of pea covered with insects. All the fields of peas around here are covered with them and they kill the peas outright. I have a field infested ; when I first noticed them was when the peas were in blossom. They appeared to be withered, so I examined them closely and found that they were covered with these little insects. The plants are now all withered and look as if they were rusted. I have found the insect also on vetches here. I inclose you a sample of these also ; they are destroyed in the same way as the peas. I am cutting them at once for fodder. I would like to know if it will be injurious in any way to feed these vetches to cattle or horses. This enemy of the pea and vetches has never been noticed in this section before.'—A. J. ARSENAULT.

'Elmhurst (King's Co.), N.B.—Our field peas shortly after the formation of the pods became infested with green lice, which were to be found on all parts of the plants,

but especially thick on the pods. The plants then turned brown and dried up so as to be useless as fodder. Is there any remedy for this pest? Would it be any benefit to have the next crop at some distance from the one infested?'—C. R. PETERS.

'Thornloe (Nipissing District), Ont., Sept. 14.—My crop of peas was entirely ruined by plant-lice about half the size of a grain of wheat, which were on the plants by millions. These peas were the first ever sown on my farm, as I only came here last fall. I would like to know if this pest is often found in open country. The clearing in this part amounts to only a few acres here and there, in an immense forest of rather light young timber. If it had not been for these lice, my peas would have been a good crop, as the land suits peas, so far as they have been tried by my neigbours.'—SAMUEL REID.

'Toronto (York Co.), Ont.—I am greatly troubled this summer with green-flies, upon my sweet peas. They are in great numbers; I never saw so many as there are this year When I went along the vines with the spray from the hose, they would fall on the ground so thickly as to make it green. There was another kind which attacked the plants under the ground clinging to the roots. This is of a brick red colour but otherwise resembles very closely the green-flies which were so numerous on the leaves and stems. When I pulled up some sickly vines last summer, I also found some of these insects clinging to the roots. These latter are not so numerous as the green ones mentioned above. Wireworms, cutworms and red spiders have also given me a great deal of trouble on my sweet peas this year.'—ED. LEADLEY.

'Freeman (Halton Co.), Ont., Aug. 7.—I send a sample of peas heavily infested with plant-lice. These are from a 14-acre field belonging to my cousin, F. W. Fisher, at Burlington, close to here. This is a fair sample; I have never seen anything like it before and should like to know if it is common. I should like to know what variety of aphis this is, for it looks as if the whole crop would be lost.'—GEO. E. FISHER.

This pea aphis was also very destructive to both field peas and Sweet Peas at Ottawa, but in the case of the field peas the outbreak occurred so late in the season that most varieties ripened before much harm was done. Sweet Peas in many gardens were badly attacked. Perhaps the worst case of infestation was upon a hedge of Sweet Peas planted rather late upon the Central Experimental Farm, where an excellent opportunity was afforded of watching the development of the plant-lice and also of a war which was waged strenuously against them by various kinds of parasites. The plant-lice clustered thickly around the young shoots and towards the ends of the branches, stunting the growth of the plants very much and preventing them from flowering. They appeared at Ottawa in the middle of August, and some specimens could be found right up to the hard frosts of late autumn. By the beginning of September several kinds of predaceous insects, such as lace-winged flies, lady-bird beetles and Syrphus flies, began to appear in large numbers, and from that time on the numbers of the plant-lice decreased rapidly. When the lady-bird beetles began to pupate, they crawled up above the vines and attached themselves to the wire netting intended for the sweet peas to climb over. This they studded so thickly as to be noticeable from a considerable distance. The species which were most numerous were *Hippodamia convergens*, Guér., and *Coccinella 9-notata*, Hbst. Next to these were the larvæ of *Syrphus ribesii*, L. This latter, however, was unfortunately rather commonly attacked by the hymenopterous parasite *Bassus lætatorius*, Fab., which again in its turn occasionally fell prey to the small Chalcid *Isocratus vulgaris*, Walk. In addition to the above parasites many specimens of *Praon cerasaphis*, Fitch, were bred from material collected at Ottawa. In one garden another minute Braconid, a new species of *Aphidius*, which has been named by Mr. Ashmead, of Washington, *Aphidius fletcheri*, did good service. The empty shells—the bodies of the hosts—from which the parasites had emerged, were very abundant on the plants. These hymenopterous parasites were kindly identified by Dr. Howard, U.S. Entomologist.

I had not an opportunity to examine material from all the localities at which this plant-louse occurred in Canada during the past summer, but parasites in numbers were found at most places; and, if the Ottawa outbreak may be taken as a guide, added to the fact that although so injurious this year the Destructive Pea Aphis has never appeared in destructive numbers before, we have reason to hope that even next year it may not again be the cause of serious loss. It must be noted, however, that the occur-

rence of the parasites seems to have been extremely restricted as to locality. The *Aphidius* mentioned above was very abundant in the garden of Mr. Collingwood Schreiber at Ottawa, while hardly a specimen could be found at the Central Experimental Farm, only two miles distant, where another parasite, *Praon cerasaphis*, took its place as the abundant species. Prof. Johnson, who has made careful studies of the insect in the United States, expressly states that he has been unable to secure a single true parasite from the many hundreds of specimens he has attempted to breed. On the other hand, he found the predaceous insects feeding upon them in some localities in extraordinary numbers. Speaking of the larvæ of one of the Syrphus flies, or Hovering flies, as they are sometimes called, he mentions one instance, as reported to him by a reliable grower, that 25 bushels of the larvæ were run through his screens the last few days they were working at threshing. At the same time, hardly a Destructive Pea Aphis could be found where only a few days previously they were present in countless millions. The Syrphus flies are very active, with bodies as a rule bronzed and marked with yellow, almost like wasps. They may be recognized by their habit of remaining apparently stationary, poised in mid air for a few seconds, and then dashing off a few feet to take up another position in the same manner. The adult flies do not themselves eat the plant-lice but their elongated leech-like larvæ live entirely upon them. The eggs are laid near the colonies, and when the young grubs hatch they crawl among the plant-lice, and having transfixed one they raise it up and hold it aloft until they have sucked all the juices out of the body. They are voracious and grow rapidly, destroying a very large number of plant-lice in a day. There are several species, all of which feed upon aphides. When full grown the larvæ harden into pear-shaped puparia, and the flies emerge soon afterwards. There are several broods in a season. The lady-bird beetles are such good friends of the farmer and gardener that everybody ought to know their appearance, but there is never a year passes but some one reports having taken great pains to destroy them when they have been found in numbers, believing them to be enemies. The grubs have aptly been said to somewhat resemble small alligators. The lace-winged flies also have larvæ of somewhat the same appearance, but smaller. They are armed with long hollow jaws with which they suck out the juices of the plant-lice, and are equally voracious with the lady-bird beetles. There are many points of interest about these lace-winged flies. The eggs are beautiful objects, being attached to the end of slende upright threads. The perfect insects have gauzy lace-like wings which, when not in use, are folded together like a pent-house over the back. Their eyes are bright golden bronze.

Fig. 9.—Fifteen-spotted Lady-bird: *a*, larva; *b*, pupa.

In Mr. Leadley's letter above quoted, mention is made by him of a bright red aphis found by him on the roots of his sweet peas. Specimens of this same aphis were sent in last year by Messrs. Steele Briggs Co, of Toronto, but the species was not identified from the few specimens sent, as no winged individuals could be found. Upon the outbreak of the Destructive Pea Aphis last summer it was thought that perhaps the species concerned might be the European *Siphonophora pisi*, Kalt., but Dr. Howard informs me that this latter is a much smaller species.

Remedies.—When an insect appears suddenly in the large numbers that the Destructive Pea Aphis did during the past season and increases with such rapidity, it is evident that it would be impossible to apply any remedy over such a large acreage as was simultaneously attacked, in most places where this insect occurred; but upon green peas and the flowering sweet peas in gardens the ordinary remedies used against other plant-lice were found to be quite effective against this one also. Upon the Central Experimental Farm the Horticulturist had the plants sprayed with a tobacco-and-soap wash made of 10 lbs. of tobacco leaves in half a barrel of water, the liquid from which was strained off after a few hours, and two pounds of whale-oil soap were added. When the soap was all dissolved, water was added to make 40 gallons, and the liquid was then applied with a spraying pump. Most of the plant-lice were found to be dead two

days afterwards and on such parts of the rows as received two applications, the vines were quite cleared of the insects.

THE ASPARAGUS BEETLES

(*Crioceris asparagi*, L., and *C. 12-punctata*, L.).

Attack.—The Common Asparagus Beetle—Slender black beetles about $\frac{1}{4}$ of an inch in length, conspicuously marked with six white blotches on the back and a red border to the neck and elytra, or wing-cases, appearing in the early spring and eating into the asparagus shoots, upon which they lay their greenish black eggs. The grubs, which hatch from these eggs, are dark olive and slug-like. These also attack the shoots. The Twelve-spotted Asparagus Beetle:—Occurring sometimes with the above, are beetles of about the same size, but slightly broader and of a uniform reddish orange colour, with twelve black spots upon the wing-cases. The grubs somewhat similar to those of the Common Asparagus Beetle, but of a dirty yellowish colour, feed inside the berries of asparagus.

Fig. 10.—The Common Asparagus Beetle: different stages on asparagus spray.

Both kinds of Asparagus Beetles have been common in some parts of the Eastern United States for many years. The former obtained a permanent foothold on this continent in 1856, and the latter in 1881.

The Common Asparagus Beetle.—The first record of this insect, as a crop pest, in America was at Astoria, near New York city, in 1862. In a most complete article on the subject, by Mr. F. H. Chittenden in the United States *Year Book* for 1896, it is stated as follows:—"From the seat of its introduction at Astoria, forty years ago, it soon spread to the asparagus farms of Queen's County, N.Y., and by 1862 it was reported to have occasioned the loss of over a third of the crops of certain localities, such loss being estimated at $50,000."

The Common Asparagus Beetle is now found as an enemy of the asparagus plant in most of the North-eastern States, lying in the Upper Austral faunal zone. Its distribution is by means of the adult beetles flying, and by their transportation to new localities with the roots of asparagus.

Last year it was reported by Mr. A. H. Kilman (*Rep. Ent. Soc. Ont.*, 1898) that it had reached the Niagara River in the State of New York, and during the past summer it occurred in injurious numbers in the Niagara peninsula of Ontario. The first Canadian specimens sent to me were from Mr. E. Arnold, of Queenston (Lincoln Co.), Ont., and upon enquiry I learn that many asparagus beds in the Niagara district were much injured last season. Mr. John Dearness, a member of the San José Scale Commission, informed me that during 1899 he had seen the beetles abundant and injurious near St. Catharines, Ont., where also he had found that the beds were badly affected with the Asparagus Rust (*Puccinia asparagi*, DC.)

Fig. 11.—The Common Asparagus Beetle —enlarged.

The Common Asparagus Beetle is a narrow black beetle a little less than ¼ of an inch in length and very prettily marked. The head legs and feelers are blue black, the thorax is chesnut red, the wing-cases are mainly blue black with six silvery white spots and are widely bordered around their edges with orange red. The markings on the wing-cases have, as shown in the illustration, somewhat the appearance of a double black cross. The wing-cases are shining and bear several longitudinal lines of deep punctures. This insect injures asparagus both in the larval and perfect states. The perfect beetles pass the winter hidden beneath rubbish, loose bark of trees or stones, and appear just at the same time as the asparagus comes up, when they fly to the buds and begin to eat into the succulent shoots, upon which also they lay their eggs. These are brownish black in colour, large, compared with the size of the beetle, being nearly one-sixteenth of an inch in length, nearly three times as high as wide, and stand out in every direction from the shoots. They are attached by one end and are laid on the shoots, and later on the foliage, in rows of 6 or 7 eggs. The young grubs hatch in a few days and are grayish with black shiny heads and legs, admirably shown in figure 12 *c*. They at once attack the young shoots, eating into them, and when touched these larvæ also emit a dirty blackish fluid which soils the shoots, spoiling them for the market. They are very voracious and grow rapidly, becoming full grown in about a fortnight, when they are dark greenish-gray, shiny bag-like grubs (Fig. 12*d*), which crawl quickly but clumsily, drawing up their bodies and attaching themselves by their anal prolegs to the object upon which they are crawling. When ready to pupate, the grubs burrow into the ground and change to yellowish pupæ (Fig. 12*e*). In about a month from the time the eggs are laid, according to Fitch, the perfect beetles appear. There are probably two broods in a season in Canada. Mr. Chittenden says (*loc. cit.*): "The minimum life-cycle period of the species in the District of Columbia and southward is about three weeks from the time the egg is laid. In the colder climate of New England and in spring and summer weather the development from the egg to beetle will require from four to perhaps seven weeks. In its northern range two and perhaps three broods are usually produced, and further south there is a possibility of four or five generations each year."

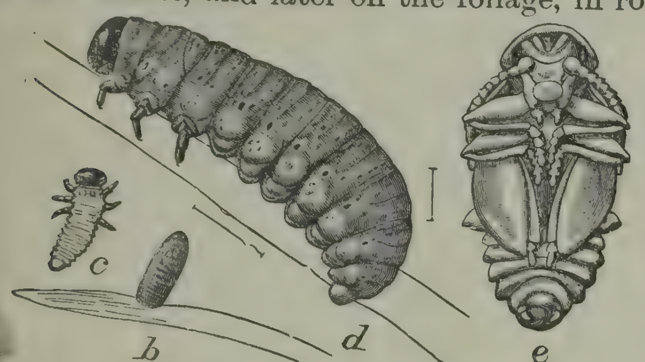

Fig. 12.—The Common Asparagus Beetle: *b*, egg; *c*, *d*, larvæ; *e*, pupa—enlarged.

Fig. 13.—Egg of Spotted Asparagus Beetle—enlarged.

The Twelve-spotted Asparagus Beetle is about the same length as the above but is a slightly broader insect. The general colour is orange red, and the wing-cases bear 12 round black spots, the knees are also marked with black. This species was a much later introduction into America than the Common Asparagus Beetle, not having been noticed until 1881, when it was found in considerable numbers at Baltimore, Md., by Prof. Otto Lugger. It has, however, spread rapidly and now occurs with, and covers almost the same area as, the Common Asparagus Beetle.

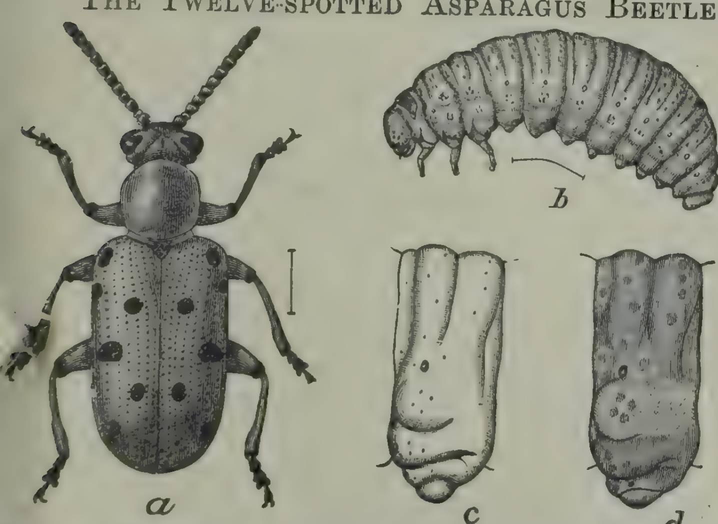

Fig. 14.—The Twelve-spotted Asparagus Beetle: *a*, beetle; *b*, larva; *c*, 2nd abdominal segment of larva; *d*, do. of *C. asparagi*—*a*, *b*, enlarged; *c*, *d*, more enlarged.

In the Canadian occurrence of these beetles during the past summer, both

species were about equally numerous on the infested beds. In the United States the 12-spotted Asparagus Beetle is regarded as rarer and less injurious than the common species. Although the hibernated beetles appear equally early in the season with the Common Asparagus Beetle and attack the young shoots, Mr. Chittenden states (*Bull. 10*, n.s., U.S, Div. Ent.) that the larvæ live chiefly in the green and ripe fruit of the Asparagus. There are, however, several records of serious injury by this species in early spring to the growing crop. Mr. Chittenden has described the eggs and the method of oviposition as different from those of the Common Asparagus Beetle (*Bull. 10*). Instead of being attached by one end and having the surface sculptured, these are attached to the plant by their sides as shown natural size and enlarged (Fig. 14). The larva also differs much (Fig. 14 *b*, *c*). Mr. Chittenden thinks that these larvæ live almost entirely in the berries, each one passing from one that it has excavated to a fresh one when in need of food. The berry drops off soon after the larva enters it, and the first brood of the beetles matures long before the berries redden on the plants. The same writer also gives the following very accurate description of some of the habits:—It is about the same size and proportions as the larva of the common species but is readily separable by its ochraceous orange colour. The ground colour is light yellowish cream overlaid with ochraceous orange; the head, with the exception of the mouth parts, is also ochraceous. Thoracic plate dark brown divided into two parts.

Mr. Chittenden gives the following very accurate description of some of the habits of these insects:—"The Twelve-spotted Asparagus beetle, as it occurs on the plant when in fruit, very closely resembles at a little distance the ripening asparagus berries. The Common Asparagus Beetle, as is well known, dodges around a stem like a squirrel when disturbed, but the Twelve-spotted form appears to trust to flight, taking wing more readily than the other. Both species make a loud creaking sound when handled. This stridulation is produced by rubbing the tip of the abdomen against the elytra."

Figures 10 to 14 in this article have been kindly lent by Dr. L. O. Howard the U. S. Entomologist.

Remedies.—Owing to the inadvisability of applying any poisonous substances to the young shoots in spring, at the time they are being cut for the market, with the object of destroying the hibernated beetles, remedies should be directed mainly against the larvæ which appear on the plants during the summer. There are many useful measures which may be taken to control these insects:—

1. Dusting with lime.—Perhaps the most effective is the destruction of the larvæ by dusting the plants at short intervals, every three or four days, with fresh air-slaked lime, which adheres to their slimy bodies and quickly kills all those with which it comes into contact. This is best done early in the morning when dew is on the plants.

2. Arsenites.—Active poisons, as a mixture of Paris green and flour, or Paris green and lime, applied dry to the grown stems in the same way as for the Colorado Potato Beetle, answer well, and kill not only by contact with the larvæ but destroy both the larvæ and the perfect beetles when they eat the poisoned foliage.

3. Beating.—The beetles and many larvæ may be beaten from the asparagus plants into nets or broad pans containing water and coal oil. Nets made specially for the purpose are most convenient. A good pattern for an easily made net which can be held beneath the plants with one hand while the insects are beaten down on to it with a light rod, has a stick on each side and a flat sheet of cotton between, three feet wide at the top and one foot at the bottom (Fig. 15). Two cross bars close together at the base allow of this net being easily held by taking the upper bar in the left hand, so that the lower bar rests against the back of the wrist. The larvæ may also be brushed off the plant with a stick, and, if this is done in the middle of a hot day, it is claimed that few of them get back again, a very short time in the hot sun proving fatal.

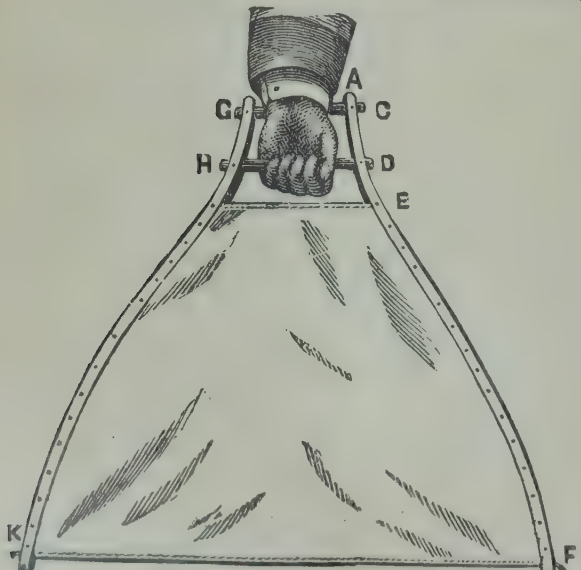

Fig. 15.—Beating net.

4. Traps.—During the cutting season the crop should be kept well down, a few shoots being left to attract the egg-laying females. In a week or so these should be cut and destroyed, other shoots being left to take their place. Young beds not old enough to be cut should be kept dusted with lime.

5. Poultry.—Chickens and ducks when available are very useful in eating the beetles when they first appear in spring, and it is claimed they do no harm to the beds.

THE BLACK VIOLET APHIS

(*Rhopalosiphum violæ*, Pergande).

Attack.—Dark coloured plant-lice clustering beneath and about the bases of the leaves and penetrating into the heart of violet plants grown under glass for winter flowering, sucking the plants and injuring them so as to prevent them from flowering, the growth being stunted and the leaves curled up.

During the convention of the Canadian Horticultural Society held at Ottawa last September, Mr. J. H. Dunlop, a large florist of Toronto and an extensive grower of violets under glass, asked what could be done to prevent the attacks upon his violet plants by the Black Violet Aphis, which he stated had been a cause of considerable loss in his greenhouses. On October 13, a visit was made to Mr. Dunlop's establishment by Mr. Arthur Gibson, of this Division, and specimens of the plant-louse mentioned were secured. These have since been bred in confinement, and specimens have been kindly identified by Mr. T. Pergande, through Dr. Howard's courtesy, as *Rhopalosiphum violæ*, a species lately described by Mr. Pergande. As a plant-louse, when examined closely, this is a very beautiful species, the body being of a brownish green, marked with black patches, and the stigma and all the veins of the wings are clearly and broadly marked with black. At the time of Mr. Gibson's visit, the aphides were very numerous, almost every plant examined in most of the violet houses being found to be infested. Very little systematic work had been done at that time towards controlling these insects. Mr. Dunlop was of the opinion that, as is known to be the case, the violet is easily injured by tobacco fumigation; consequently, little smoking had been done. Later, however, the attack became more serious and was the cause of a loss in this year's violet crop, estimated at $1,000. Fumigation with tobacco had been resorted to for three weeks at intervals of one week apart, at the time of a second visit paid by Mr. Gibson on December 26. Powdered tobacco stems had also been dusted over some of the plants. These applications had killed many of the aphides, and the insects were then practically under control, but the plants were showing many spotted leaves. The treatment of violet plants with tobacco is considered objectionable by the best growers. Mr. B. T. Galloway, Chief of the United States Division of Vegetable Physiology, who has studied the commercial culture of violets and is the author of an excellent book upon that subject, writes as follows with regard to some leaves which were submitted to him from Mr. Dunlop's houses where the fumigation had been done:—'The violet leaves are affected with the well-known spot which is very apt to appear at almost any season of the year under certain conditions. In our experience we have never found it safe to use tobacco in any form on violets; even the very weakest fumigations have a tendency to weaken the foliage and bring on spot. My suggestion in this case would be to thoroughly clean the plants, withhold water from the foliage for two or three weeks and keep a night temperature of about 40 degrees, with a day temperature of 55 or 60 degrees. In other words, attempt to give as good conditions as possible to bring the plants to health.'

Remedies.—For greenhouse plant-lice and certain other insects, the most generally adopted method to prevent such attacks is the fumigation with tobacco in its various forms. In the case of violets, however, as Mr. Galloway states, the tobacco fumigation tends to weaken the foliage and cause the 'spot' to appear. In an excellent bulletin recently issued by the United States Division of Entomology (*Circular No. 37, 2nd*

Series), the use of hydrocyanic acid gas for greenhouse fumigation is recommended, as of particular value to violet growers. Indeed this line of application of the gas is said to have been specially devised for violet houses by Messrs. Woods and Dorsett, the authors of the bulletin, who are officers of the Division of Vegetable Physiology and Pathology, and the latter is a practical violet grower. Careful and exact directions as to the proper way of using the gas, together with the necessary precautions which must be taken to avoid danger to the plants or to the operator, are given. Different plants are liable to injury in a varying degree, so that it becomes necessary to know the strength of the gas which may be used with each class of plants. Many experiments have been tried with this end in view, and directions are given in the bulletin cited for some of the leading greenhouse plants, e.g. :

'Double English Violets.—"Marie Louise," "Lady Campbell," and others. For plant-lice and general fumigation, fifteen-hundredths of a gram of 98 per cent cyanide of potassium for each cubic foot of space is required. The exposure, if made according to directions, will not hurt the plants in any stage of growth. The gas has been used on a large scale in fumigating violets for the past three years with the greatest success, only a few treatments during the season being required. Leaf-eating larvæ, slugs, millipedes, cutworms, &c., when exposed, are killed as well as plant-lice. Red Spiders, however, are not entirely eradicated by the treatment. The foliage of single violets like California and Princess of Wales are sometimes slightly injured by the stronger dose of gas. A weaker dose (one-tenth of a gram cyanide of potassium per cubic foot) should be used when they are to be treated.'

THE CLOVER MITE

(*Bryobia pratensis*, Garman).

Attack.—Reddish brown mites $\frac{1}{25}$ of an inch in length, oval in shape and with remarkably long front legs, causing the leaves of fruit and other trees, as well as of clover, to turn yellow.

This species of mite belongs to the same family of vegetable feeding mites, the *Tetranychidæ*, as the ordinary so-called 'Red Spider,' often found on house plants and in conservatories, and which also attacks orchard trees, rose and currant bushes, sweet peas, and other low plants, causing the leaves to assume a sickly appearance and to dry up. The eggs of the Clover Mite frequently come in from inquiring correspondents. They are ruby red in colour, broadly rounded above and comparatively large, about $\frac{1}{100}$th of an inch in diameter. They are usually deposited in large flat mat-like clusters in and around crotches of the branches of orchard trees, particularly of plum trees, and often in sufficient numbers to give a distinct red colour to the bark. Specimens of eggs were received first from British Columbia, and since then have come from many parts of Ontario, and as far east as Gaspé in the extreme east of the Province of Quebec.

Though spread over such a large territority in Canada, the Clover Mite does not seem to have attracted attention by its injuries anywhere except in British Columbia, until last summer, when the following letter was received :

'Queenston (Lincoln Co.), Ont., July 17.—With this I send you some twigs of some Niagara Plum trees. They are much paler green than others and are evidently affected by some insect, possibly the Red Spider. Did you ever know this insect to work on plum trees in this manner? The entire foliage of large trees seems affected. What had I better do to check it? Is it dangerous?'—C. E. Fisher.

In Canada the Clover Mite passes the winter in the egg state, but in many parts of the United States it has been complained of from time to time in the last ten years as an unwelcome invader of dwelling houses in the mature state, during autumn and winter. The small size of the Clover Mite enables it to go through ordinary wire screens with ease to the serious disquietude of the house-keeper.

The large number of inquiries about this mite, both on account of its invasion of houses in autumn and of its injuries on trees and other plants, made it necessary for the United States Entomologist to publish a special circular on the subject (*Circular No. 19*, Second Series).

Though the injuries to fruit crops by the Clover Mite have not been serious in Canada east of the Rocky Mountains, a good deal of harm is done in the Pacific States and in British Columbia to many fruit trees, particularly plums, apples, almonds and cherries, and together with other kinds of mites this is often spoken of under the general name of 'Red Spider.' Besides the injuries above referred to, there is no doubt much damage is done by this insect to clovers and grasses which is overlooked.

Remedies.—The protection of fruit trees from the attacks of this mite is not difficult where the winter is chiefly passed in the egg state on the trunks of trees. It has been found that spraying the egg masses during the winter with kerosene emulsion diluted with five parts of water will destroy the eggs without injuring the plants. Their entrance into houses in autumn may be prevented by spraying the lower portions of the buildings with pure kerosene, and, if the mites are found infesting grasses or other plants, these latter should also be sprayed with kerosene emulsion diluted with nine parts of water, to which some finely powdered sulphur can be added with advantage. When the mites have gained access to a house, they may be destroyed by the free use of pyrethrum insect powder or by burning brimstone in the room. Gasoline or benzine may be sprayed over them, but these liquids are dangerous from their extreme inflammability, and hot water frequently applied would answer the same purpose.

THE GREENHOUSE LEAF-TYER

(*Phlyctœnia ferrugalis*, Hbn.).

Attack—Slender semi-translucent green caterpillars, when full grown nearly an inch in length, with two distinct black spots close behind the head, the green dorsal vessel showing distinctly down the middle of the back, bordered on each side with a double white band, feeding inside a slight tent made by drawing the sides of leaflets together with silk threads. The cellular tissue of the lower sides only of the leaves is eaten.

During the past summer I had brought to my notice injuries to roses in the greenhouses of Mr. J. H. Dunlop, of Toronto, by the caterpillars of a small European moth, which has been introduced into America for some years and has been occasionally noticed as a greenhouse pest, and on one occasion as injuring celery out of doors in Michigan. Mr. Dunlop first noticed the work of this insect about three years ago, when it destroyed the whole of the roses in one of his houses, and did much harm in others. The only effort to control it was by catching the moths and destroying them. Every year since 1897 the caterpillars have been the cause of some loss. On October 13 last, Mr. Arthur Gibson visited the houses and saw large numbers of the moths flying among the roses and resting on the sides of the house. Living caterpillars were also found of all sizes at this time and appeared to feed almost entirely on the under sides of the leaves, eating away the soft green tissues and spoiling the appearance of the foliage. From the time they hatch until full-grown, the caterpillars live in tents made by drawing down the leaflets of the leaves; the cocoons are spun between the leaves. In a work entitled *Commercial Violet Culture* by Mr. B. T. Galloway, of Washington, it is stated that violets are sometimes attacked during the summer by this insect, the larvæ attacking the leaves and destroying the softer parts, leaving only the skeleton or frame of the tissues. The caterpillars are surrounded by a light web and occasionally two leaves are fastened together to give them protection. It is further stated that the insect never produces serious injury, but it is advisable to watch for it and take such steps for it as may be practicable. The picking of the leaves containng the larvæ is recommended and, if it should become abundant, fumigation with hydrocyanic acid gas.

A second visit was made on December 26, and although the specimens were many fewer, the houses having been carefully gone over, a moth was found flying, and a cocoon containing the living pupa, but no caterpillars. Mr. Dunlop states that the caterpillars may be found all through the winter.

The following description was taken of the larvæ :

Full-grown caterpillar,—Length at rest, $\frac{3}{4}$ of an inch. General appearance: slender, semi-translucent green caterpillars with the dark green dorsal band showing distinctly through the skin, rather fainter on 2nd, 3rd, and 13th segments. This is bordered on each side by a double white sub-dorsal band, which also is rather fainter on the 2nd, 3rd and 13th segments. On the 2nd segment are two distinct black spots, one on each side. Head one-twenty-fifth of an inch in width, smooth and shining, whitish, splashed with light brown on the cheeks, slightly furrowed at vertex, and bearing a few pale hairs. Mandibles brownish ; ocelli black. Spiracles white and very small, joined by a faint whitish line. On the 2nd, 3rd and 4th segments this line is represented by a few faint white dots and is obsolete on segment 13. Thoracic feet and prolegs of the same colour as the body ; the thoracic feet each bear exteriorily two black dots, one above the other. The whole body is sparsely covered with slender pale hairs, the ventral surface lighter in colour than the dorsal. When at rest these caterpillars have a habit of curling round to the side of the body, their heads and the first three or four segments of the body. The length of the pupal period in October was 17 days.

THE RASPBERRY WEB-WORM

(*Lyda multisignata*, Nort.).

Attack.—Bright green smooth false-caterpillars, when full-grown over half an inch in length, which web together many of the leaves on raspberry canes, making a tent in which several of the caterpillars feed together.

A rather interesting new enemy of the raspberry has for some years occurred at St. John, N.B.; larvæ were received in 1898, from which two males and a large number of female saw-flies were reared last summer. These have been kindly identified by Dr. Howard as *Lyda multisignata*, Nort. The caterpillars when full-grown are over half an inch in length, the head round and smooth, the cheeks and back of the head chestnut brown, as well as the mandibles, and a large round patch in front of the face. Ocelli black. On the segment next to the head is the thoracic shield, which in some specimens is also darkened with brown patches, and on each side of the throat beneath, running across the same segment, from the back of the head to the bases of the first pair of thoracic feet, is a short dark brown chitinous band. Antennæ 7-jointed, and for caterpillars conspicuous. On each side beneath the last segment is also a 3-jointed antenna-like appendage protruding downwards. These appendages in *Lyda* are called abdominal antennæ by Dr. A. S. Packard in his *Text Book of Entomology*, 1898, page 165, and a figure is given of a *Lyda* larva which might almost be used as an illustration for the species under discussion. The upper flap of the last segment is rounded at the tip and bears three dark triangular marks extending from the base towards the apex, but not reaching it ; the median, only half the length of the lateral ones ; lying in a depression at the extremity, there is also a distinct median dark dot. The lower flap of the last segment, dark brown narrowly margined with green, and as well as the upper, bearing a sparse fringe of short slender bristles.

This attack was first brought to my notice by Mr. George Raymond, of Bloomsfield (King's Co.), N.B., who wrote under date August 1, 1898 :—'A friend of mine in St. John has a small garden, where she has been growing raspberries for a number of years. For the last six years they have been troubled with a worm on the leaves, at first very small, and on the under side. As they grow, they spin a web drawing the leaves all round them and destroying the foliage. They have been much more destructive this year and it is only by persistent picking of the leaves that they can be kept in check.'

Miss H. Raymond, in whose garden the injury was done, wrote a full account covering most of the facts mentioned above, but stating that the larvæ were gregarious, about six being found in the same tent, and from her account and from specimens forwarded to the Division the attack of this species upon raspberries resembles very

closely that of another Lyda which has been found in southern Manitoba upon plum trees (*Lyda rufipes*, Marl.) and was treated of in my report for 1896 at page 253.

Upon rearing the perfect insects, which emerged at Ottawa from the middle to the end of June, specimens were sent to Miss Raymond, and she subsequently wrote saying that she had often seen these flies upon the raspberry bushes about the middle of June. She also stated it was about six years since the insect had appeared in troublesome numbers, and it had been worse during the past four.

Remedies.—As these caterpillars appear on the raspberry bushes at the time the berries are forming, it is inadvisable to use Paris green and similar poisons. Moreover, Paris green has been found to be more injurious to raspberry foliage than to some other plants; if therefore poisons are used, the vegetable poison, white hellebore, is preferable, because, although very fatal to many insects and particularly to all kinds of sawfly larvæ, the poisonous principles, being very soluble, are soon washed away by rain and dew, and there is little danger in using the fruit a week after an application of white hellebore. As, however, the tent-like webs are very conspicuous and this is certainly a very uncommon insect, the method of handpicking which has been successfully adopted by Miss Raymond, will probably in most outbreaks answer all purposes.

THE APIARY.

The following report has been handed in by Mr. John Fixter upon the Apiary, at the Central Experimental Farm, the management of which as heretofore has been left entirely in his hands.

REPORT OF MR. JOHN FIXTER.

The Season of 1899.

April 1.—Eighteen colonies were removed from the winter quarters: six were placed in the House Apiary, six in the sheltered apiary, and the other six in the exposed apiary. In the case of the two last there was a considerable depth of snow on the ground, from 1 foot to 18 inches, The hives had to be watched as the snow melted to prevent them from toppling over. From April 1 to 4, there was scarcely any flying, but from the 15th to the 17th, there was much more. The hives in the exposed apiary were covered with coarse sacks as a protection, leaving a very small entrance for the bees. In the sheltered apiary and House Apiary no such protection was given. The bees in these apiaries appeared to work better than those which were exposed. On many days when the weather was cool, with cold winds, those that were sheltered were flying well, while none of the others were.

The balance of the colonies were taken from their winter quarters on April 17. All began to fly at once and no mixing appeared to take place. The colonies that were set out early were flying as well as is usual in the month of May. From April 17 to 23, many of the bees were flying every day, when the first pollen was noticed, being brought in off the swamp maples and willows. From April 20 to 30, the bees were seen gathering sap off hard maples that were running, and also off hard maple stumps where trees had been lately cut.

From May 1 to 15 the bees gathered a great amount of pollen, but very little new honey, and nearly every hive was full of brood and young bees—the first drones were noticed May 24. A considerable amount of honey was fed from May 15 to June 1, so as to keep up brood rearing and to prevent starving.

Up to June 1 there were many flowering trees and shrubs in bloom, but there was no increase in honey. From June 1 to 6, the bees were flying well, gathering pollen, but no increase in honey. On June 6 Alsike Clover came into bloom. Up to June 17 there was no honey gathered. From June 18 to 30, the bees gathered a great deal of honey from clover and raspberry.

On July 3 the first honey was taken off. July 8 the basswood trees were well out in bloom, bees appeared to be very thick on the flowers, but there was very slight increase in weight of hives; during the balance of July, bees gathered very little honey, and there was no increase in the weight of the hives after August 1. The autumn flowers gave no surplus, and there being no buckwheat sown in this district in 1899, no honey was gathered from that source.

The season being such a poor one for honey gathering, all the summer experiments have been left for another season. It is intended to test the different hives with equally strong colonies—Langstroth 8 and 10 frames, Jones hive and Hedden hive—also to test each kind for comb-honey and extracted honey; different-sized sections and further different-sized pieces of foundation in the sections.

House Apiary.

The House Apiary was again tested with two tiers of hives. This plan can be safely recommended for cities or towns where space is limited, and two tiers can be arranged just as well as one in the same building. This plan can also be highly recommended in sections of the country where the hives are continually being disturbed by boys or in any unused buildings which can be looked up.

Returns.

The past season has been a very poor one, both as to the quality and as to the quantity of honey. The returns per hive of the Central Experimental Farm Apiary for the season of 1899 show an average of only eighteen sections per colony. The colonies which were run for extracting gave 23 pounds per colony. Swarming was well kept under, very few colonies being allowed to swarm. The total number of colonies at the end of the season is sixty.

NOTES ON SUMMER MANAGEMENT OF BEES.

There is scarcely a place in Eastern Canada where bees cannot be kept profitably. There are, of course, some localities more favourable than others for the purpose, and there are certain seasons which are so unpropitious that bees have to be fed and little or no surplus honey is stored; but, on the whole, with careful management, bee-keeping may be made not only a remunerative occupation but a source of a great deal of pleasure to those engaged in it.

The keeping of bees may be practised almost anywhere, even in large cities, in towns or villages, as well as on the farm. In cities or towns the hives may be placed on the roof of any building where they get some shade, or, what is better, the hives may be kept inside a room, as explained under the head of House Apiary in previous reports. An important point, however, is to place them where they can be watched carefully during the swarming season.

I would advise placing the hives on their summer stands early in spring without waiting, as is done in many sections, until the soft maples and early willows bloom; but advantage should be taken of the first calm day when the temperature is about 60 degrees. When carrying the bees out, have weighing scales near at hand, also clean bottom boards to replace those which have been in use all the winter, and which must be cleaned before using again. Weigh at once and note the number and weight of each hive, the number for reference, and the weight to know what amount of stores is still left to carry the colony over until the honey flow. On a very warm day when there is no

wind, examine each colony and see that it has a good laying queen and plenty of stores. Should there be insufficient honey, give them a frame of honey with the cappings scraped off, placing it as close to the brood as possible, also close the entrance more or less according to the strength of the colony. If the colony is very strong, the entrance may be left about two inches in width; if weak, close down to about one-half inch. Great care should be taken to protect the hives from cold draughts in spring. As the weather gets warmer and the colonies stronger, open the entrances. On many days the bees in the House Apiary and in the sheltered apiary will be flying and gathering pollen, while the bees in the exposed apiary are at home keeping the cold air off the brood. If you have a propolis quilt or chaff cushion on the hives, leave it there until the colony is strong enough for a super for sections, or for extracting frames; then all should be removed.

The time for putting on supers is when the hive is full of bees and there are good prospects of a honey flow; by allowing plenty of room, swarming will be prevented to some extent. In this section of the country great care should be taken to see that each colony has plenty of honey during the period between the fruit bloom and clover bloom. Many failures at this time are due to lack of stores, and too much attention cannot be paid to this point. I would advise feeding if necessary up to the clover bloom to force brood-rearing, so as to have the colonies strong. Excessive swarming may be forced or prevented as desired.

If swarms are desired, crowd the bees and stimulate them with syrup. I would not advise allowing more than one swarm from each colony. To prevent excessive swarming give the bees plenty of room and do not wait until they swarm, but put on the supers as soon as the colony is strong enough to work in them. Should swarming occur, remove the hive to another stand, take a new hive, put the swarm into it and place it on the stand from which the swarming hive was removed. The old colony may be further weakened by taking out several frames and shaking all the bees off in front of the newly hived swarm.

For hives placed in a garden choose some convenient place near the dwelling where those busy about the house can see any swarms as soon as they leave the hive and settle. It is better to locate the hives away from the immediate proximity of high trees because when the bees swarm they are apt to settle too high up to be secured without much trouble. When gathering a swarm, a most important help is Manum's wire cloth swarming device, or a similar one, even a large pail attached to the end of a pole, will answer. The use of these will save many swarms and many stings for the operator. The pole may be made in joints so as to allow of extension to the required height. There are many patterns of swarm collectors, most of which consist of a ring of stout wire about 2 feet in diameter, bearing a bag of some light material of about 2 feet in length. This is put up beneath the swarm and the bees shaken into it. It is then lowered and the bees are emptied out in front of a new hive, already prepared for them.

Swarms which settle on shrubs, are much more easily handled. All that is required is to take a piece of sacking, spread it on the ground under the swarm, place the hive properly prepared on the sacking, give the limb or shrub a sharp jar, when the swarm will drop in front of the hive and at once enter it. Another excellent plan is to take a frame of drawn comb or a frame of unsealed brood, and draw it up against the swarm; a large majority of the bees will soon gather upon the frame, which should then be placed in a hive with several more frames. Those bees which have already clustered on the frames will begin to call their companions; as soon as a few have found the entrance they will announce their discovery by the usual vibration of the wings ('humming'). Should the swarm still cling to the tree or shrub, a bunch of grass or a twig from an evergreen is useful to brush them off with. The hive should be left until the bees have all entered it, and as soon as they have done so, the hive should be carried to its permanent location in the apiary. If the colony is a strong one and the season favourable, place at once on the hive a super or extracting frames. When the honey flow and swarming seasons begin, everything should be in readiness to receive the swarms. Supers should be filled with sections, each of which is provided with a full sheet of foundation, and the extracting frames should also have full sheets of foundation in them, and must be

wired so as to prevent the heavy combs from breaking when the honey is being extracted. Even in the brood frames, full sheets of foundation are preferable, except perhaps for some expert apiarists.

The time to remove section honey is when the supers are fairly well filled and capped; it is best not to wait until the corner sections are filled, as these if not full enough may be put back into the next super. When removing the section honey, start shortly before sundown, smoke the bees at the entrance, then take a wide chisel and gently pry off the super and stand it on end, close to the entrance of the hive; leave it there a short time, then remove it to the honey room, leaving the doors and windows open all night for such bees as still remain on the comb to escape. By the following morning all the bees will have either returned to the hive or gone to the fields. The doors and windows of the honey room should be closed very early the next morning, or robbing will take place. Comb honey should not remain on the hive to be daubed after the sections are sealed. Remove the honey to a very warm dry room, where it will ripen thoroughly. The extracting frames may be left on the hive to ripen until the busy honey season is over; they may be tiered up two or three high. When an empty super is added, put it at the bottom next to the brood chamber. When removing extracting frames, a bee-escape is placed between the extracting super and the brood chamber, and at night the bees will descend through this but cannot return again, When all the bees are down, remove the frames to the extracting room. All honey, whether in comb or extracted, should be kept in a warm, dry room.

JOHN FIXTER.

THE WORST WEEDS OF THE NORTH-WEST.

Strange as in may seem, it is no easy matter to decide off hand what is the *worst weed* in a district, and even in a single locality there is frequently great diversity of opinion on this point. Judging from the replies of correspondents, the 'worst weed in the district' seems to mean the one plant which has given most trouble at a recent date to the farmer who happens to be interrogated.

There are, however, certain plants which, for one reason or another, every year prove to be troublesome and aggressive enemies of the farmer, causing loss of crop, necessitating extra labour, or compelling him to treat or utilize his land in a way other than he would wish.

From a close study of this subject in the West during the past five years and after consultation with the energetic and competent Weed Inspectors of Manitoba and the North-west Territories, Messrs. Charles Braithwaite, of Portage la Prairie, Man., and T. N. Willing, of Regina, N.W.T., respectively, it seems to me that the following plants are specially noxious, and every effort should be put forth to destroy them when detected, or to prevent their introduction to new localities.

STINK WEED or Penny Cress (*Thlaspi arvense*, L.), miscalled sometimes 'French Weed.' Annual. Introduced. A most pernicious and persistent weed with a strong nauseous odour and which endures the lowest temperatures of the West with impunity. Young plants overtaken by winter before their seeds are formed, revive in spring and mature in June; the seeds are produced in enormous numbers, and there are two complete crops ripened every year. This plant belongs to the same natural order as the mustard and cress, the turnip, and the cabbage. The milk of cows which eat it, is tainted and unfit for food. As a field pest it is a vigorous grower, crowding the crop and robbing the land of moisture. The succulent nature of the leaves and stems render it very dificult to kill unless destroyed when quite young.

Remedy.—Plough down before the seed pods form and harrow fallow-land constantly so as to destroy all seedlings. Land for summer-fallowing upon which plants with fully formed pods occur, must be mowed over and the plants burnt before turning down.

Land under grain crops should be harrowed two or three times with a light harrow having sloping teeth or with a weeder, from the time the grain is two inches high until it is six or even eight inches. Mr. Willing says 'Stink Weed is decidedly the hardest weed we have to handle, and some of it has been found in all districts where farming has been carried on to any extent from Manitoba to the foot hills, and from the United States boundary to the Saskatchewan.'

WILD OAT (*Avena strigosa*, Schreb.).—Annual. Introduced. Closely resembles some varieties of cultivated oats, but ripens its useless hairy seeds irregularly, so that many fall to the ground before the grain they grow among is ripe, thus crowding the crop and infesting the land with a useless and aggressive weed. Mr. Braithwaite says: 'After Stink Weed, the Wild Oat has certainly done farmers the most harm this year.' There are in Canada three kinds of Wild Oats which have been introduced from Europe. The kind most abundant in many parts of the North-west and British Columbia is the Black Wild Oat (*A. strigosa*).

Remedy.—The best means of clearing land of this pest is to work it in early spring and, when many of the seeds have germinated, go over it again with a disc harrow and sow a very early variety of oats or barley, to be cut twice as green feed and then turned down. If this land can be used the following year for a hoed crop or roots it will be better than sowing grain.

CANADA THISTLE (*Cnicus arvensis*, Hoffm.).—Perennial. Introduced. The Canada Thistle, so-called, is extremely abundant in some of the rich lands of the Red River valley and is well established in many spots right across the continent to the Pacific. West of Manitoba, however, it is far less troublesome than many other weeds. Mr. Braithwaite says: 'I may say I am more concerned about Canada Thistle and Tumbling Mustard than any others of our weeds. The Thistle is spreading rapidly from vacant government lands north and east, and the Tumbling Mustard has spread from the North-west down through the Souris districts.' Mr. Willing views its spread in the North-west with anxiety; he says, 'Canada Thistle seems to have come to stay and is very plentiful along the northern branches of the railway, but, it is true, many other weeds as yet are giving more trouble to farmers.

TUMBLING MUSTARD (*Sisymbrium altissimum*, L.).—Annual. Introduced. This coarse member of the Mustard Family was only introduced into the wheat fields of the West about ten years ago, but it has now spread from Indian Head, where it was first noticed, eastward through Manitoba and westward to the interior of British Columbia. Mr. Willing says 'Tumbling Mustard is now more plentiful than any other weed in south-eastern Assiniboia.' Tumbling Mustard has all the bad charac-

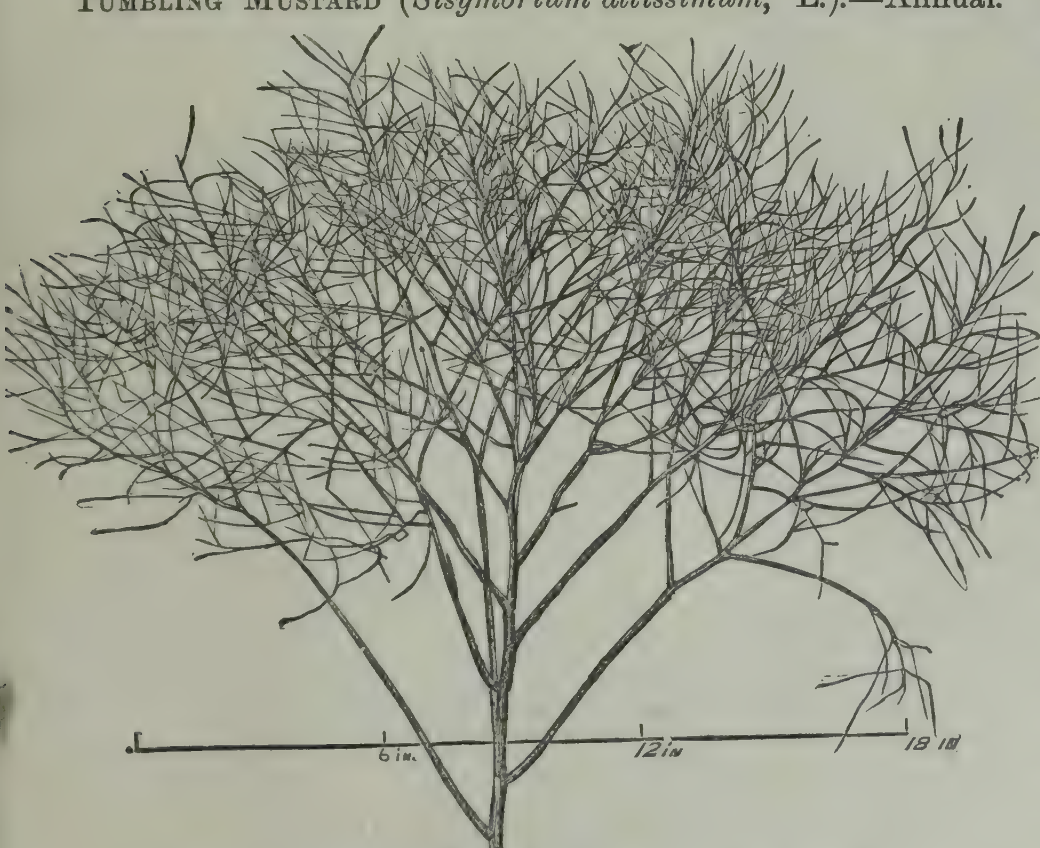

Fig. 16.—Tumbling Mustard: a tumbler with ripe seeds.

teristics of the other mustards and besides is a large free-growing, exceptionally prolific plant, of which when the seeds are ripe the head breaks off and becomes a 'tumbling weed' (Fig. 16), which may be blown for miles across the prairies in the autumn and during the winter, thus scattering the seeds quickly over wide areas. The reddish or greenish-brown seeds are very small, and a single plant produced one million and a half by actual count. Owing to the small size of the seeds, they are easily cleaned from grain. The distribution of the plant is almost entirely by the wind blowing the heads across the prairies during the winter.

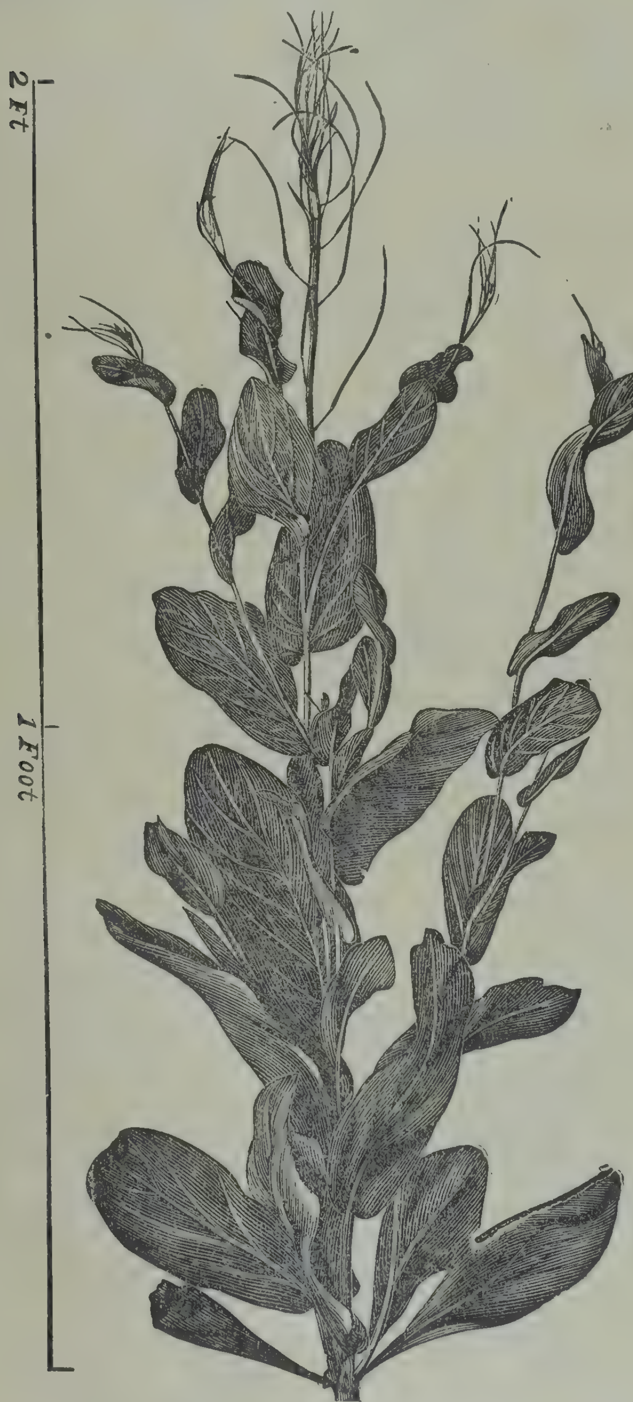

Fig. 17.—Hare's-ear Mustard.

Remedy.—The best means of clearing land of this and other kinds of mustard mentioned below consists of harrowing or cultivating with a weeder the growing crops of grain as long as possible in spring, and subsequently hand-pulling the flowering plants and mowing them down at the edges of fields, on road allowances, railway banks and waste places.

Hare's-ear Mustard [*Conringia orientalis*, (L.) Andrz.].—Annual. Introduced. This is an extremely injurious plant with large leaves, grayish-green, like those of a young cabbage or field pea, but shaped like the ear of a hare or rabbit ; flowers small and creamy white, followed by long square pods from 3 to 4 inches long, a vigorous grower and an absorber of much moisture. The ripe stems, sometimes 4 feet high, are wiry and stiff, and give much trouble when grain is harvested, not only in cutting, but also in binding and handling. The seeds of this plant are much larger than those of the Tumbling Mustard and are frequently found in seed grain, with which they are distributed. The Hare's-ear Mustard now occurs widely through Manitoba and the North-west Territories. Mr. Willing places it third in his list of the worst weeds.

False Flax (*Camelina sativa*, Krantz).—Annual and winter annual. Introduced. A slender-branched plant of the Mustard Family which matures early, the numerous pear-shaped pods containing several seeds. This is widely spread in the West. The chief causes of its increase in the past has been the late date at which summer-fallowing has been done.

Fig. 18.—Ball Mustard.

Ball Mustard [*Neslia paniculata* (L.) Desv.].—Annual Introduced. A tall, slender, somewhat branching, orange-flowered plant, with a great number of small single-seeded almost round pods, each one borne on a slender foot-stalk. Like the Tumbling Mustard and the Hare's-ear Mustard, this is a recent introduction into America, but has spread through the wheat-growing districts with alarming rapidity. Mr. Braithwaite says: 'This is a very bad weed as is shown by the way it has spread.' Mr. Willing writes of it: 'Ball Mustard has made more headway in Alberta and Saskatchewan in a given number of years than any introduced weed.'

Wild Mustard (*Brassica sinapistrum*, Bois.).—The true Wild Mustard or Charlock, also called Cadluck and Herrick, is not, compared with many others, a common weed in the West. The plant most frequently spoken of there as Wild Mustard is the Bird Rape (*Brassica campestris*, L.). The two plants may be easily distinguished. In Wild Mustard the stems and leaves are rough, the joints of the stems marked with purple, the knotted pods about one inch long on short thick foot-stalks, erect and tipped with an empty or one-seeded two-edged beak. In the Bird Rape the stems and pods are perfectly smooth and glaucous, the pods, which are from 1½ inches to 2½ inches in length, stand out from the stem on slender spreading foot-stalks.

Shepherd's Purse (*Capsella Bursa-pastoris*, Mœnch).—Annual. Introduced. This plant, like the Stink Weed, is frequently overtaken by winter when in full flower, but is in no way injured, the flowers and pods of the late autumn developing the following spring and producing an early crop of seeds. Few people have paid the attention to this weed in the West, which its noxious character, as it there develops, demands, and as a consequence it is increasing and spreading in an alarming manner, not only in gardens but in wheat fields. Owing to the early date at which the minute seeds develop and the enormous numbers in which these are produced, I fear this weed is going to be a cause of serious loss to western farmers. The plant is easily recognized by its rosette of cut-up leaves lying close to the ground, and bearing from the centre a much branched stem covered from bottom to top with numerous flat triangle-shaped pods. This weed is a close relative of the Stink Weed, and land infested with it should be specially attended to. The seeds are frequently too ripe by the middle of June to allow of their being ploughed down without danger. Summer-fallows should therefore be cultivated or mowed before being ploughed.

Lamb's Quarters (*Chenopodium album*, L.).—Called in different places by several other names, in Manitoba most widely known as Pigweed, also as Fat-hen, Goosefoot and Wild Spinach. Lamb's Quarters, however, is the name used over by far the largest area in Canada, and Pigweed properly belongs to the common Amaranth or Red-root. The Lamb's Quarters, which is an annual plant, of which there are both native and introduced forms, the latter, however, being by far the most abundant in the West, finds in the highly fertile and slightly alkaline soils which prevail there, just such conditions as enable it to develop most luxuriantly, and it is so prevalent in some seasons as to cause a very large loss to farmers, not only in crowding out and robbing the grain while growing, but in every other way reducing the value of the crop by increasing the labour and expense of harvesting, threshing and shipping, and the subsequent and always unpopular dockage for weed seeds by the grain buyer or miller. The Lamb's Quarters prevails to so much greater an extent than any other weed that with some farmers the word 'weeds' means nothing else. It is a succulent annual which does not ripen its

seeds very early in the season; therefore, if land is harrowed before sowing and the grain sown in favourable weather, the crop, as a rule, gets well ahead and keeps the lead over the weeds, so that these do not develop to an injurious extent. In springs when there is cold weather after seeding, the seeds of the hardier weeds germinate more quickly than any of the cultivated grains, and in the constant struggle which goes on throughout the season between a crop and its weed enemies, the one which gets the best start, as a rule, holds the advantage to the end. The farmer is able to help much in this struggle to his own advantage, by using improved methods of farming suited to his own land and the variations of the season.

Remedy.—With annual weeds, the main point to be aimed at is to destroy them as seedlings and as soon as possible after the green seed leaves appear. No weed seedling can spring up on land except from a seed, and, if all weeds can be destroyed by any means before they ripen their seeds, the land, in time, must become clean. The method of harrowing growing grain lately practised in the West with excellent results is, I believe, the cheapest and best means of controlling Lamb's Quarters and all other annual weeds which every year do so much harm in western wheat fields, many of which are so large that no other manner of treating them is practicable.

WILD BUCKWHEAT (*Polygonum Convolvulus*, L.).—Annual. Introduced. In certain seasons this climbing bindweed is a terrible pest in the West, many acres of crop being entirely ruined by it. The seeds ripen very irregularly, some of them before the date at which summer-fallows are generally turned down. Western farmers, however, are wisely summer-fallowing much earlier and oftener than has been the custom in the past, and, although in this way they may increase their labour to the extent of one or even two harrowings, there is no doubt that many weeds will noticeably decrease in abundance, this abundance having been largely due to the frequency with which ripe seeds were ploughed down upon land summer-fallowed after the middle of July. Speaking of the last year or two, Mr. Willing says: 'Wild Buckwheat and Lamb's Quarters are getting away with as large a share of the farmer's profit as any of the weeds which occur here.'

Remedy.—The early and regular summer-fallowing of land every third year. Mr. Braithwaite has tried and strongly recommends a method of treating land infested with Wild Buckwheat. He says: 'I have found that, if an ordinary harrow be turned upside down so that the nuts and the tops of the teeth only protrude, a growing crop of grain may be cleaned of most of the Wild Buckwheat by simply dragging the inverted harrows across it. Of course, if a weeder is used at the right time this will never be necessary, but this weed germinates very quickly and roots deeply. When it has about three leaves, it is very tender and the harrows will break off or pull up millions of plants or check them and give the grain a chance.'

RUSSIAN PIGWEED (*Axyris amarantoides*, L.).—Annual. Introduced. This is a tall coarse-growing plant with a hard woody stem which up to the present has not given much trouble in grain fields but is spreading rapidly in Manitoba and the Territories along railways. Farmers will do well to watch it closely and prevent its increase. It belongs to the same family as the Lamb's Quarters.

COW COCKLE (*Saponaria Vaccaria*, L.).—Called also Soapwort, Cow Herb and China Cockle. A soft succulent annual with pretty pink flowers, belonging to the Pink Family, which was introduced into southern Manitoba from Europe. It has spread with rather alarming rapidity through many parts of the prairie provinces. The seeds are round, hard and black, two or three times as large as those of Wild Mustard, the surface is slightly roughened, a character by which they can be easily distinguished from the seeds of wild vetches, which are of about the same size.

GREAT RAGWEED (*Ambrosia trifida*, L.).—Annual. Native. This is the 'Crown-weed' of millers. As an aggressive weed the Great Ragweed seems to be largely con-

fined to the rich lands of the Red River valley. It is a very coarse tall-growing plant, which does not ripen its seeds until late in the season. Summer-fallowing every third year and a little hand pulling during the two crop years will soon clear land of this weed. The Great Ragweed is particularly obnoxious to grain buyers and millers, owing to the difficulty with which its seeds are separated from grain, as they are of about the same size and weight as the grains of wheat and consequently cannot be easily blown or sifted out of wheat.

Canada Fleabane (*Erigeron Canadensis*, L.).—Called also Horseweed and incorrectly 'Fireweed.' Annual. Native. A tall wand-like plant with small greenish-white flowers, to be seen with the two common biennials False Tansy (*Artemisia biennis*, Willd.) and Common Evening Primrose (*Œnothera biennis*, L.) upon all summer-fallows. These three plants all of them flower much later than the time when land should be summer-fallowed to get the best results, both for controlling weeds as well as for the more important reason, in the West, of conserving moisture in the ground. The best remedy then for these is to summer-fallow early.

Blue Bur (*Echinospermum Lappula*, Lehm.).—Annual. Introduced. A weed which has appeared only of late years in the West but has spread very rapidly, owing to its bristly barbed seeds. As a rule this weed is a denizen of waste places and roadsides, but it is gradually working its way into the crops. The seeds ripen about the middle of July ; therefore land should be ploughed before that date to prevent the plants from seeding.

Fig. 19. Peppergrass

Peppergrass (*Lepidium apetalum*, Willd.).—Native. Winter annual. A weed which occasionally appears very abundantly, particularly on light land and in wet seasons. For the most part the seeds germinate in the autumn and the seeds are produced the following season. The appearance of the plants in autumn and spring is as flat rosettes of narrow deeply indented leaves lying close to the ground with a single central tap root. Disc-harrowing in autumn and spring is the best treatment of land for this and other plants of a biennial habit.

Skunk-tail Grass (*Hordeum jubatum*, L.).—This grass is one of the most troublesome weeds in hay. Although it may when young be cut as hay and fed without danger, the hard ripe seeds often cause very painful sores in the mouths of horses and cattle, as they are very sharp-pointed and barbed. They run down by the side of the teeth, or penetrate any soft part of the mouth particularly beneath the tongue and into the tongue itself. There are two distinct forms of this grass, one with long silvery awns, 2 inches long, and another with a more erect habit which has awns little more than half that length. Various methods have been tried to clean hay lands of this troublesome pest, but none with much success. If the Skunk-tail Grass is cut when quite young, it makes tolerably good feed, and hay lands where it occurs should be mowed early before the ripening of this injurious grass. A method of cleaning hay practised at Gladstone, Man., is to toss the hay with a pitch fork on a windy day before using it, when most of the light feathery heads of the Skunk-tail Grass will blow away from the hay and may then be gathered up and destroyed. Whenever this grass is seen in waste places or roadsides it should be mowed before it is ripe and burnt.

This grass is generally described as an annual, but in Manitoba it is certainly a biennial, and apparently sometimes a perennial. It is a bunch grass and has no running root-stocks, growing only from seed.

Native Perennials.

FIG.— 20. Indian Hay.

There are a few native perennial plants which are troublesome weeds on farms. Among these may be mentioned the WHITE-STEMMED EVENING PRIMROSE (*Œnothera albicaulis*, Nutt.), the SPREADING DOGBANE (*Apocynum androsæmifolium*, L.), the BLUE LETTUCE (*Lactuca pulchella*, DC.), SKELETON WEED (*Lygodesmia juncea*, Don.), POVERTY WEED, or Smotherweed (*Iva axillaris*, Pursh), the PRAIRIE ROSE (*Rosa Arkansana*, Porter), and INDIAN HAY, or Sweet Grass (*Hierochloa borealis*, R. & S.). All of these on account of the difficulty with which they are eradicated have in different districts been stigmatized as 'the worst weed in the country.' They are all deep-rooting perennials with great tenacity of life, and the method which on the whole has given the best results, is to plough deeply in summer after the plants have drawn off a large amount from their supply of reserve material laid up by the leaves in the underground stems during the preceding summer. The broken up root-stocks, however, will still have much vitality, and if left undisturbed will throw out fresh shoots, and the land will be in a worse condition than before. To prevent this, about a month or less after the first ploughing, the land should be disc-harrowed, and this operation should be repeated again a month later, when the root-stocks of most plants will be so far weakened as to be past recovery. A few, however, as the Canada Thistle, Blue Lettuce and Sweet Grass, may require further treatment and the placing of the land under a hoed crop the next year.

Occasional Weeds.

There are every year, probably dependent on the season, certain plants which, appearing suddenly, draw general attention by their abundance over greater or smaller areas. Some of these are of little importance, but others sometimes cause considerable anxiety and loss. Among these may be mentioned the following :—

WORMSEED MUSTARD (*Erysimum cheiranthoides*, L.).—A biennial plant with acrid principles in all its parts, the seeds particularly having caused death in cattle when fed in quantities among other seeds screened from wheat.

SMALL-FLOWERED WALLFLOWER (*Erysimum parviflorum*, Nutt.).—A native biennial, sometimes abundant in land which has been left without summer-fallowing for too long a period.

WESTERN WALLFLOWER (*Erysimum asperum*, DC.).—Last year one of the most conspicuous plants in some crops in western Manitoba and south-eastern Assiniboia was the beautiful golden-yellow-flowered Western Wallflower, or Prairie Rocket. This is a native biennial very easily pulled from the ground, and, although on account of its brightness it was much noticed, it can hardly be classed as a noxious weed. It very

seldom grows to a large size in crops and is easily killed by autumn or spring cultivation.

Yellow Whitlow-grass (*Draba nemorosa*, L., var. *a*, *leiocarpa*, Lindl.).—This is a small few-branched winter annual, seldom more than four to six inches high, with few leaves and a great many smooth pods about half an inch in length on slender wide-spreading foot-stalks. The flowers are bright yellow, borne at the ends of the branches. There is no danger, I believe, of this feeble native plant ever becoming an aggressive crop pest, but it was conspicuously abundant on almost every summer-fallow through Manitoba and the North-west Territories last June. At every one of the twenty-one meetings held, specimens were shown or questions were asked about it.

Gray Tansy Mustard (*Sisymbrium incisum*, Englm., var. *Hartwegianum*, Watson).—Native. Biennial. A tall grayish-green slender plant 3 to 4 feet high, very leafy at the base and bearing at the summit a compressed panicle, thickly loaded with short erect pods. The leaves are very finely divided and cut up, from which fact it is sometimes inaccurately spoken of as 'Rag-weed,' a name which belong to quite a different plant. This crucifer was the most striking unusual plant on western wheat fields and summer-fallows last year, attracting the notice of everybody by its tall cones of grayish green leaves standing up above the young grain in June. Mr. Braithwaite writes: 'The Green and Gray Tansy Mustards were very much in evidence this year, but, being natives and biennials, they only showed up on breaking, summer-fallows, or in crops sown on stubble. Our farmers are now understanding the nature of the different kinds of weeds, and will in future control this kind by late fall or spring cultivation.'

Green Tansy Mustard (*Sisymbrium incisum*, Englm., var. *filipes*, Gray).—Somewhat like the last, but of a bright yellowish-green colour, and without the hoary pubescence, the branches, instead of being close together, spread loosely and form an open head, the seed pods also are borne on slender spreading foot-stalks, and the leaves are much more finely divided. A character which makes this a more dangerous weed than the last, although as yet it is the rarer of the two, is that the seeds ripen very much earlier, so that there is more danger of the ripe seed being ploughed in when land is summer-fallowed.

Golden Fumitory (*Corydalis aurea*, Willd.).—An occasional weed in Manitoba is this biennial fumitory. While in the East, where it is rather an uncommon plant on rocky banks, the stems seldom exceed 6 inches in length, in the Manitoban wheat fields patches from 2 to 3 feet across are not uncommon, and instances have been reported to me frequently of several acres of crop being choked out by it.

Tarry Cockle (*Silene antirrhina*, L.).—A plant which could hardly have been suspected of ever developing into an agricultural pest is the slender-stemmed member of the Pink Family, to which the name of Tarry Cockle has been given. This is a plant with an upright stem bearing (in the West) many erect branches, each joint of which has a dark brown sticky patch to which dust and insects adhere. I have seen this occurring in some quantity at different places, and specimens are frequently sent in by farmers for name. Last summer Mr. Braithwaite found large patches of it in crops at Blythe, south of Brandon, in Manitoba, and the Rev. W. A. Burman saw at least 400 acres near Carberry so infested that the weed had almost crowded out all the wheat.

Three-flowered Nightshade (*Solanum triflorum*, L.).—Called also Wild Tomato. A native annual plant with deeply indented leaves, and the whitish flowers in umbel-like, three-flowered cluster, followed by green or purplish berries, about as large as small cherries; the whole plant has a musky odour, pleasant at first but afterwards very nauseous. This weed is a coarse decumbent herb forming patches 2 or 3 feet across, and is frequently troublesome in gardens and around the edges of fields.

SPEAR-LEAVED GOOSEFOOT (*Monolepis chenopodioides*, Moq.).—Annual. Native. A dark green succulent plant forming thick patches wherever soil is a little alkaline. Frequently growing so abundantly in root crops and gardens, as well as in wheat fields, as to require much labour to keep it down. The leaves of this plant are borne very thickly on the clustered stems, the lowest ones shaped like the head of a halberd or spear, but those above becoming gradually simpler in outline and smaller. Short seed-bearing spikes occur along almost the whole length of the stems.

WEEDS AND WEEDERS.

The introduction of weeders into the dry regions of the West, I consider an event of enormous importance to all grain growers. During the past five summers I have had exceptional opportunities, in driving through Manitoba and the North-west Territories, of meeting, and seeing the farms of, some of the best farmers in the West. In many places I have met men who made a practice of harrowing their growing grain crops with a light harrow, and invariably with great advantage. Upon the introduction of the various weeders these were used by a few of the most enterprising settlers, and almost always with decided satisfaction. So much was this the case that last spring several carloads of them were shipped into Manitoba by implement makers. The season of 1899, however, was so wet and late that the weeders were not used so much as would ordinarily have been the case. From what I have seen of these implements here, but particularly at the Indian Head and Brandon Experimental Farms, and from what I know to be the condition of the wheat fields in Manitoba and the North-west Territories with regard to annual weeds, I am convinced that there is more to be hoped for in the regular use of these implements after the grain is up, than from any other measure so far suggested for cleaning lands infested by such aggressive and persistent agricultural pests, as Stink Weed and the different kinds of Mustard, as well as all other seedlings growing among grain crops. Weeders can be used not only safely, but with the greatest advantage to a grain crop, from the time the leaf is an inch high until the plants have shot up 6 or even 8 inches.

One of the frequent complaints made against weeders by western farmers is that they cover too narrow a strip of the crop at a time, but in the *Farmer's Advocate* of Winnipeg for December 5, at page 612, is given a cut, which the proprietors have kindly allowed me to use here, showing a successful way of uniting two of these implements and covering 24 feet at once. In this way the writer, W. F. Baker, of Portage la Prairie, states that he can go over nealy 50 acres in a day. The two weeders are fastened together with a rope, and the horses are kept apart by a stick between the halters. The wheat in the fields reported upon, had been cultivated twice after it was 4 inches high, and he says, as has been found by many others to be the case, and as I have myself frequently seen: 'If properly used when weeds are very small, nearly all weeds can be destroyed. On July 18, the wheat thus cultivated was 4 feet high and nicely out in head. The field shown in the cut was 70 acres of the first crop after summer-fallowing. It yielded 1,800 bushels (nearly 26 bushels to an acre), and so far as shipped, graded No. 1 hard. Another 70-acre field cultivated with the weeder, yielded 29 bushels, while a larger field, that we thought did not require a weeder, yielded only 17 bushels.'

Fig. 21.—Two weeders joined.
(Cut kindly lent by the *Farmer's Advocate*.)

Mr. Angus Mackay, at Indian Head, has the greatest confidence possible in these implements, and last year used them on every acre he had under grain.

There has been considerable inquiry during the past year or two as to the treatment of grain crops infested with mustard, with solutions of sulphate of iron and sulphate of copper. There is no doubt whatever, as I have proved by experiments here and the Rev. W. A. Burman has shown in Manitoba (1898), that the annual mustards can be killed and even Stink Weed, when young, seriously injured by solutions of sulphate of copper, as weak as 2½ pounds to 10 gallons of water. On this subject I would merely point out that, at the very lowest estimate, and using the most economical effective solution yet recommended (2 per cent sulphate of copper*), $1 per acre would be the very lowest estimate at which the cost of this operation could be calculated. In the West where a good many of the farmers work several hundred acres, which they frequently never visit again after the spring work is done, until they turn in the reapers at harvest time, this extra expense including the purchase of spraying pumps and sulphate of copper, and the extra work of drawing water, and mixing and applying the solution, would be far less advantageous or likely to be practised, than the use of weeders or light harrows, which most certainly is better farming; for this operation, besides doing better work in destroying the seedlings of all kinds of weeds, has been proved to be most beneficial to the growing crops by reason of the extra cultivation thus given to the land at the very time when it requires it, and the fields so treated yield much heavier crops.

Mr. Charles Braithwaite, who has had greater opportunities of forming an opinion on this matter than any other man in Manitoba, replies as follows to an inquiry as to the utility of surface cultivation of growing grain crops :—

'PORTAGE LA PRAIRIE, Oct. 9, 1899.—I may say that, from my own observations, in ordinary years I certainly agree with your opinion. Working growing grain with light harrows or weeders has a twofold advantage: it destroys weeds and also creates a mulch which prevents moisture from evaporating. Of course, this year being a moist year, the work could not be done as effectually as in drier years. During the season of 1898, Mr. Henry Nichol, of Brandon, had two weeders and kept them going until the grain was 5 and 6 inches high. His crop averaged 30 bushels per acre, while his neighbour's did not average over 15 bushels, and some within 5 miles of him had to plough up their crop on account of weeds and drought. I had this from Mr. Nichol himself, and he is, as you know, a thoroughly reliable man. I could tell you of scores of others who have saved their crops by this method. Of course, as I tell the farmers, this surface cultivation of grain with any kind of implement must be done with common sense, not too deep nor too shallow, and, when the land is in proper condition for harrowing, not too wet and not too dry.'

THE WHEAT CROP IN MANITOBA IN 1899

The wheat crop in Manitoba in 1899 has been estimated at 27,000,000 bushels, almost all of excellent quality and exceptionally free from weed seeds. This satisfactory result is due chiefly to the season. The late date at which severe frosts occurred allowed almost the whole crop to be got in without injury, and the freedom from weeds was due largely to abundant moisture last spring and the previous autumn. On account of cool wet weather last spring, seeding of wheat was much delayed, but the seeds of many weeds being in the ground germinated quickly and came up in the first warm days. Enormous numbers of these seedlings were destroyed at the time the grain was sown; thus the land was clean of all the weeds that had germinated, and the wheat being put in under the most favourable circumstances, germinated promptly and got ahead of the weeds. In addition to the benefit due to the wet spring of 1899, the exceptionally wet autumn of 1898 was also very beneficial by causing many of the seeds of annual weeds to germinate before winter set in, so that they were destroyed by frost These, under the usual climatic conditions which prevail in ordinary years in Manitoba and the West, do not, for lack of moisture, germinate before the following spring. As a

* See article by Mr. Shutt, page 194.

consequence of the above mentioned circumstances, the fields were exceptionally clear of weeds last spring, a satisfactory state of affairs which lasted until the end of the season.

The following extracts from letters of men who can speak with authority illustrate this point.

Mr. H. McKellar, who as Chief Clerk of the Department of Agriculture meets farmers from all parts of the province and receives reports throughout the season on the condition of the crops, says as follows :—'I have made reference on two or three previous occasions to the absence of weed seeds in this year's crop. The fact that the grain is much cleaner this year than it has been for several years is commented upon by everyone who handles grain. In fact, I might say that this year one hears nothing about dockage for weed seeds. This merely bears out the excellent appearance of the fields which we noticed in driving through them together last June and July.'

Mr. Charles Braithwaite, who as Provincial Weed Inspector travels continously over the province, inspecting crops and advising farmers how best to treat their land and avoid loss from weeds, writes : 'This is without exception the cleanest crop the West ever reaped. The climatic conditions were favourable ; last summer and fall there was moisture enough to germinate weed seeds, and then again this last spring there was a good growth of weeds before the land was fit to seed. The weeds germinated and and were destroyed in the cultivation at seeding time, and the grain came right away.'

The following report is from Mr. G. H. Greig, of the *Farmer's Advocate*, who has good opportunities of judging :—

'Winnipeg, Oct. 11—The crop generally speaking through Manitoba and the West is very much cleaner and freer of weeds than it has been for some years. The assumption is that, owing to the excessive moisture in the soil last spring, seeding was not started as early as usual, and consequently a great many weed seeds would germinate before any cultivation was given the land ; the seedlings were afterwards killed by the cultivation at seeding time. At all events, the season has not been favourable to weed growth, and crops are cleaner than they have been for years. No doubt, very much credit for this desirable state of affairs is due to the excellent work done by local department of agriculture in holding meetings during the past three years, at which the nature of weeds and the best way to fight them were explained.'

The following report by Mr. F. T. Shutt, Chief Chemist to the Dominion Experimental Farms, will be read with interest by those seeking information as to the remedial treatment of mustard with sulphate of copper and sulphate of iron. The application of these solutions may be found useful in small areas in the East or in British Columbia, but is not a practical nor advisable method to recommend on the large farms in the drier regions of the West.

SPRAYING FOR DESTRUCTION OF MUSTARD.

By Frank T. Shutt, M.A., Chemist, Dominion Experimental Farms.

One of the most persistent weeds that farmers in many parts of Canada have to contend with is mustard, commonly known in Europe as Charlock. Though an annual, it is most difficult to eradicate from fields in which it has become established, owing to the fact that the seed—of which a large number is formed—are endowed with a strong vitality and are preserved from decay by the oil they contain, until favourable conditions for sprouting occur.

Pulling the mustard when it appears among the grain, or keeping the weed from seeding by working the land (as under a hoed crop), are the two methods which have hitherto been in vogue to exterminate this pest, and when the work is done thoroughly they may be considered satisfactory and efficient. The former, however, is always costly, and the latter is sometimes not convenient. When, therefore, it was announced in the agricultural press that spraying with certain solutions of sulphate of iron and

sulphate of copper had been tried successfully in England and France, it was deemed advisable to make similar experiments here. We should then be in a position to furnish information at first hand on this subject.

The fields of the Experimental Farm being free from this weed, it became necessary to make the trials upon an adjoining farm, and for that purpose a field of barley was selected which showed a considerable amount of mustard. The size of the plot treated in each case was one-tenth of an acre, and the quantity of solution uniformly supplied to each area was 5 gallons, or at the rate of 50 gallons per acre. The date of spraying was June 26, the grain being 15 inches to 20 inches high, and the mustard practically the same height and just coming into flower. The chief data may be briefly stated as follows :—

Sulphate of Iron, 5 per cent.—No effect upon barley. The leaves were practically all stripped from the stems of the mustard, but the weed was not killed, as evidenced by new leaves subsequently starting the plant flowering and the seed-pods filling out and maturing. The leafless stems were quite green a fortnight after the spraying, and were apparently furnishing nourishment to the seed.

Sulphate of Iron, 10 per cent.—A slight scorching of some of the leaves of the barley was to be noticed. A fortnight after the spraying this was not discernible, and, though this spray may have *slightly* retarded growth, it is not probable that the yield of grain was affected.

Though the effect upon the mustard was more pronounced than in the foregoing instance, as noticed by the 'spotting' on the stems, it was not sufficiently strong to prevent flowering and the ripening of the seeds, a large proportion of which proved, upon testing, to be vital.

Sulphate of Copper, 2 per cent.—A certain amount of injury to the leaves of the barley resulted, evidently retarding growth to a somewhat greater degree than the 10 per cent iron sulphate solution. At the end of two weeks, however, this effect had practically all disappeared, and it became doubtful if there were any permanent injury to the grain. The mustard very quickly showed the effect of the spraying, both the stems and the leaves dying without allowing the plant to seed. Two weeks after spraying, a few living mustard plants were found in the plot, but it is believed they had escaped the solution, owing to the height and overshadowing of the barley.

Sulphate of Copper, 5 per cent.—This solution damaged the barley in a much more pronounced manner than the preceding solution ; in all probability it somewhat lessened the yield of grain, though, as the ground was very uneven in character, no comparative data on this point could be obtained.

The mustard was all killed ; an inspection two weeks after the spraying did not reveal any living plants.

In order to ascertain the effect of these solutions upon this weed at a younger stage of growth than that just reported upon, mustard seed was sown in rows in a plot upon the Experimental Farm. When the mustard plants had reached the height of 6 to 9 inches they were sprayed as follows :—

July 20 : *Sulphate of Iron, 5 per cent.*—Not all killed ; the few survivors possessed green stems and in time sent out new leaves. It is extremely doubtful, however, if the plants will have sufficient strength to flower.

Sulphate of Copper, 2 per cent.—All the plants died within a few days.

July 22.—Further sprayings were made : *Sulphate of Iron*, 5 per cent. The stems were stripped of all their leaves, but in the course of a few weeks fresh leaves had appeared on many of the plants. *Sulphate of Iron*, 10 per cent : Though somewhat more severely attacked than by the 5 per cent solution, there was sufficient vigour left in many of the plants to send out new leaves after a few weeks.

Sulphate of Copper, 2 per cent: Only a very few of the older and more vigorous plants escaped destruction, probably not more than three to five per cent. This solution is evidently strong enough to kill all mustard plants 6 inches in height and less.

Sulphate of Copper, 5 per cent.—All the plants killed.

From the above data, I make the following inferences:—

1. That a two per cent solution of sulphate of copper (that is, 2 pounds in 10 gallons of water) is, all things considered, the most effective, safest (as regards the grain crop) and most economical to use. The spraying should be done thoroughly, and for that purpose 50 gallons per acre will be required. If a heavy rain follows the spraying within 24 hours, the operation will have to be repeated.

2. That, in order that the work may be effective, spraying should not be delayed after the mustard plants have reached a height of 6 to 9 inches. If allowed to grow taller than this, stronger solutions would be necessary and in larger quantity, as the grain would then largely protect the mustard.

NOTES ON LECTURING TOURS IN MANITOBA, THE NORTH-WEST TERRITORIES AND BRITISH COLUMBIA IN 1899.

By instruction of the Honourable Minister of Agriculture and at the request of the several governments of Manitoba, the North-west Territories and British Columbia, I left Ottawa in June last to hold three series of farmers' meetings in the West. The subjects of the addresses delivered were chiefly as follows: In Manitoba, locusts and weeds; in the Territories, weeds and their eradication, special mention being made of the value of summer-fallowing and the use of the implements known as weeders, and nature studies and agricultural education in schools; in British Columbia, the value of Farmers' Institutes, weeds and their eradication, insects injurious to fruits, hay and pasture grasses.

Leaving Ottawa on June 10, I reached Manitoba on the 13th. Passing along the railway between Ottawa and Manitoba, the backwardness of the season was remarkably apparent. Spring flowers which had been in bloom at Ottawa a month earlier, were only now opening their buds. This lateness was also a feature of the season all through Manitoba and the Territories.

Manitoba.

Upon reaching Winnipeg, I made an examination of the shade trees, which are such an attractive feature of this beautiful city, and found that the Ash-leaved Maples were infested by three different insects: (1.) the Negundo Plant-louse (*Chaitophorus negundinis*, Thom.), (2.) the Cankerworm (*Anisopteryx pometaria*, Harr.)—both of these although much less abundant than in former years, still required attention—and, lastly but much more conspicuous, (3.) the Fleshy Leaf-gall of the Negundo. This is a fleshy swelling on the mid ribs of the young leaves which disfigures them very much. The galls are about an inch in length and contain several yellowish larvæ of a small gnat probably belonging to the genus *Diplosis*. An article was prepared for the press under the caption of 'Spray the Trees,' which was published in the local newspapers, and many availed themselves of the advice given therein.

On June 13 I reported myself at the Provincial Department of Agriculture, and, having been joined by Prof. Otto Lugger, the State Entomologist of Minnesota, I left Winnipeg on the 14th, and with Mr. Hugh McKellar, the Chief Clerk of the Provincial Department of Agriculture, who had made arrangements for an investigation of the areas in southern Manitoba, which were infested by the Rocky Mountain Locust in 1898. We reached Boissevain on the evening of the 14th and held a well attended meeting of farmers the same evening. The first

Fig. 22.—The Rocky Mountain Locust.

address was delivered by Mr. McKellar, who explained what steps had been taken by the Honourable Thomas Greenway with a view to assist the farmers to avoid loss by locusts, which were so abundant in 1898 as to have caused considerable anxiety, and, as none of the observers who had been on the lookout for the egg-laying females last autumn had succeeded in observing any, the hope had been expressed that there would be no locusts this year. The department, however, feared that this was too hopeful a view of the matter, and, on account of the gravity of the case, the Minister had requested the Dominion Entomologist and the State Entomologist of Minnesota to visit the district and examine whether there was any probability of an outbreak of locusts in 1899. Reports had been received that the insects had begun to appear south of Boissevain and Deloraine, and, although the date at that time was three weeks later than when the locusts had appeared last year, it was considered wiser to have the matter investigated carefully, so that, if locusts were found, farmers might be visited and urged to use the methods of destroying the insects which had been found useful elsewhere.

I then followed with a statement of all that was known of the Manitoba occurrences of the Rocky Mountain Locust, the extent of the losses which might accrue if farmers did not adopt the simple and inexpensive means of controlling them which had been advised. Prof. Lugger explained in a lucid manner the life history of this locust, which he illustrated with some large and original charts and gave the results of his long experience in fighting locusts in Minnesota and Dakota. The measures advised were practically those which had already been made known widely through newspapers, agricultural journals and government reports, and were briefly as follows :—The ploughing down in autumn and spring of all stubble in the districts where locusts had been seen, the ploughing down of the young locusts with the stubble as soon as possible after they hatched, beginning at the outsides of fields and working towards the centre; wherever the young had hatched and made considered growth before the stubble was ploughed down, the use of the hopper-dozers, and on restricted areas the poisoning of the insects with arsenical mixtures.

Mr. Charles Braithwaite, the Provincial Weed Inspector, was also present and spoke at this meeting; he also accompanied us through the rest of our investigation, in which he was of much assistance.

Fig. 23.—Messrs. Fletcher, Lugger and McKellar finding locusts' eggs.

On the morning of the 15th we started early and drove down to the beautiful farm of Mr. A. S. Barton, and thence to Mr. Frank Thompson's, where the exact localities could be pointed out in which the locusts had occurred the previous year. No trace of the insects or their eggs was found; indeed, there was, both here and during a 25-mile drive to Deloraine, a most remarkable absence of all kinds of locusts or 'grasshoppers,' the name by which they are generally spoken of in the West. On reaching Deloraine, we were met by Mr. John Renton, of that place, and Mr. Thompson, of Waskada, who told us that hoppers had been seen on the hatching grounds six miles south of Deloraine, where I had found them last year. Accordingly, we drove to these farms, where they had been most abundant, and made a thorough search for the eggs. We soon saw that young locusts were hatching in large numbers, some were just emerging from the eggs, and some unhatched; many egg-pods also were empty, but showed that the eggs had been destroyed by parasites. The egg-pods were about an inch below the surface, mostly on elevated spots, and on the sunny side of furrows on these elevated spots. This date of hatching (June 15) was fully three weeks later than that at which the young grasshoppers must have hatched last year, for I found fully matured insects on July 4, 1898. This was due to the late wet spring, a circumstance which also was of great benefit to farmers by making it easier for them to control weeds.

On the evening of the 15th a meeting was held at Deloraine, which was wel attended by farmers from the surrounding country, and addresses were delivered similar to those given at the Boissevain meeting, except that we were now able to speak strongly and definitely as to what steps it was advisable for the farmers to adopt without delay. At this meeting Mr. D. S. McLeod brought specimens of locusts from Lennox, only a few miles south-west of the Deloraine occurrence; these were apparently a week or more older than any we had seen in the fields we visited. At this meeting Prof. Lugger gave the chief address of the evening, describing in detail the best means to adopt under the present conditions to prevent the spread of the swarms now hatching; he also showed plans and explained thoroughly the construction of hopper-dozers, in case these implements should be required later in the season. From what we had seen, however, we were able to encourage the farmers to hope that, if all would plough down the stubbles left for summer-fallowing at once, the locusts might be prevented from spreading and causing serious loss.

After the Deloraine meeting we left for Napinka and took the early morning train to Brandon, where a profitable morning was spent examining the magnificent crops on the Brandon Experimental Farm. The Awnless or Smooth Brome Grass, the introduction of which by the Experimental Farms has been such an immense boon to the farmers of the West, was at that time (June 16) just spearing, and the meadows were a thick mat of grass, over two feet in height. In the afternoon a good opportunity of meeting many of the best farmers of the province was afforded at the ploughing match of the Blythe Farmers' Institute, held near the Brandon Hills Post Office. Here we were again invited to deliver addresses on our grasshopper investigations, a subject which proved of much interest to the hundreds of farmers present. We returned to Brandon in the evening, and on the morning of the 17th I separated from my very pleasant companions.

Owing to the excellent arrangements made by Mr. McKellar and by the generosity of the Northern Pacific and Canadian Pacific Railways who had given the whole party free transportation over their lines, we had been able in a very short time to travel a long distance and also to meet the farmers most keenly interested in the locust occurrences. That the farmers of southern Manitoba appreciated the efforts of the governments to help them, is attested by the following letter received from Mr. McKellar at the end of the season :—

'There is no doubt but that your visits to Manitoba in 1898 and June 1899, examining the Deloraine district, invaded by grasshoppers, did much good. Farmers were interested in the definite information given by you regarding the habits of the grasshoppers and the best methods for fighting them. Instructions *in re* fall ploughing or early spring ploughing and early summer-fallowing have been followed. A few farmers have used hopper-dozers this season, and if necessary, more will be used the coming year. The injury done in 1899 was not appreciable. The crops were of very heavy growth, and the harm done, therefore, not so evident. There has been more fall ploughing in the Deloraine, Whitewater and Boissevain districts last fall than in any previous year. This was partly on account of the very favourable fall, but farmers were no doubt stirred up to the work by the knowledge that they were taking the best means possible for destroying the eggs of grasshoppers that might have been deposited during the summer.'

North-West Territories.

June 18 was spent in answering correspondence which had been forwarded to me from my office at Ottawa, and on the afternoon of the 19th I left for the West, reaching Moosomin at 4 o'clock, in time to join the Honourable G. H. V. Bulyea, the Commissioner of Agriculture for the North-west Territories, and hold an afternoon meeting of farmers; this was the first of a series of seventeen meetings held in the southeast of Assiniboia. These meetings were arranged by the Commissioner to be held at the points where it was considered good work could be done by explaining to farmers living in that magnificent and fertile section: (1) the exact meaning of the North-west Noxious Weed

Ordinance and the attitude of the Provincial Government on the subject; (2) the nature of noxious weeds, the danger of many varieties being introduced from the East; and giving a detailed description of the kinds most to be feared in each locality, with the best means of eradicating or fighting against them. The order of the meetings was as follows: The Commissioner, who was present at almost every meeting, opened with an exposition of the Weed Ordinance; I followed with a treatment of the subject of weeds and their eradication, illustrating my remarks with fresh specimens of the worst weeds to be found in each locality, either brought in by farmers or collected before the meeting. There were also shown prepared specimens of those not yet introduced but which were to be feared and which might appear at any time among crops. At most of these meetings we were accompanied by, and received much assistance from, Mr. Wm. Trant, of Regina, who not only took an active part in the meetings but prepared careful accounts of each for the press, in which the chief features of the addresses were presented in an excellent manner. Some of these meetings were also rendered much more attractive and useful by the presence and timely addresses of the active Deputy Commissioner of Agriculture, Mr. C. W. Peterson, and the Territorial Weed Inspector, Mr. T. N. Willing, who is both an expert botanist and also a practical farmer who has lived for many years in the West. It will be seen by the list of places given below where meetings were held, that a large area of country was visited, the exceptional fertility of which was clearly proved by the prosperity of the farmers, as evidenced by the fine houses and buildings and the well-kept farms.

At Regina we were honoured by the presence of His Honour the Lieutenant Governor of the North-west Territories, the Honourable A. E. Forget, who took an active part in the proceedings.

The series of meetings began at Moosomin on the 19th and ended at Gainsborough on July 7. They were convened through the different agricultural societies, and in every instance an officer of the local society presided. The enthusiastic welcome accorded the Honourable Commissioner and the keen interest shown in the subject as evinced by the large attendance at all the meetings, and the animated discussions, were very gratifying. The numbers which were present were remarkably large considering the distance most had to travel, and the fact that it was necessary to hold these meetings at a very busy time of the year for farmers.

The following is a complete list of the meetings held, with the name of the chairmen:

Date.	Place.	Chairman.
1899.		
June 19	Moosomin	J. M. L. Young, President, Agricultural Society.
" 20	Whitewood	R. Nicholson, " "
" 21	Grenfell	R. D. Lake, M.L.A., " "
" 22	Wolseley	Dr. Elliott, M.L.A., " "
" 23	Indian Head	Angus Mackay, " "
" 24	Qu'Appelle	W. H. Henley, " "
" 26	Fort Qu'Appelle	A. Macdonald, " "
" 27	Regina	G. Spring-Rice, " "
" 28	Moose Jaw	Jno. Battle, " "
" 29	Fairmede	J. Clementson, " "
" 30	Glen Adelaide	Wm. Piggott, " "
July 1	Clare	J. L. Thompson, " "
" 3	Carlyle	Jno. Stewart, " "
" 4	Alameda	S. Miller, " "
" 5	Oxbow	D. W. Maitland, Secretary, "
" 6	Carnduff	Jno. Young, " "
" 7	Gainsborough	Wm. Taylor, President, "

After the Moosomin meeting we went by freight train to Whitewood, arriving there early in the morning of the 20th. The morning was spent in collecting plants

with Mr. T. N Willing. We took the evening train for Grenfell, where we were met by Mr. R. D. Lake, through whose kindness I was driven out to his home and had an opportunity of seeing the nature of the country and its condition as to the prevalence of weeds. The following morning further opportunities were afforded by a 15-mile drive round by the farm of Mr. T. Skilliter and back to Grenfell, where a very largely attended meeting was held, one of the best of the whole series. After the meeting I returned with Mr. Lake to Col. Lake's house, and the following morning was driven to Wolseley, where we held another good meeting in the new Court House. At Whitewood we were joined by Mr. F. Blakely, of the *Nor'-West Farmer*, who remained with us for all the subsequent meetings but the last. Owing to the much greater altitude, the crops from Moosomin to Grenfell and Wolseley were not nearly so forward as in Manitoba. Winnipeg is about 700 feet above sea level, while Grenfell is nearly 2,000. All crops, however, were in splendid condition and there was every prospect of an enormous yield, the land being, as a rule, clean and well worked.

We reached Indian Head on June 23, when I was met at the station and driven out to the Experimental Farm by Mr. Angus Mackay. During the morning the whole of our party was driven round the farm. Crops of all kinds were in the best of order, and a remarkable object lesson was here seen of the very great value of using harrows and weeders upon growing grain crops. These as a whole were much more advanced than at Grenfell, and those which had been harrowed showed this fact plainly by their greater vigour. The meeting in Indian Head in the afternoon was well attended, and, as was to be expected, summer-fallowing and the surface treatment of growing grain were much discussed. Mr. Mackay has probably taken a more active part than anyone else in the North-west in insisting upon the necessity of a proper system of summer-fallowing for the dry regions of the West, and, as a remarkable confirmation of the accuracy of his views, lands which ten or fifteen years ago were abandoned because it was stated they were too far west and too dry to produce paying crops of wheat, are at the present time selling at a higher price than any other lands in the North-west Territories.

On the morning of the 24th Mr. Mackay kindly drove me himself to Qu'Appelle station and on the way pointed out many features of agricultural interest. The meeting was held in the afternoon, and, like the next one at Fort Qu'Appelle on the following Monday, was particularly well attended, the large number of questions asked and free discussion of the addresses being noticeable features in both places.

On Monday morning June 26, through the kindness of Mr. Donald McKay, I was driven to Fort Qu'Appelle and had a chance to examine many growing crops on the way. This locality was of particular interest because it was from here that the first reports were received of the occurrence as crop pests of the Tumbling Mustard and Hare's-ear Mustard. After the meeting at Fort Qu'Appelle, I drove back to Qu'Appelle Station with Deputy Commissioner of Agriculture Peterson and Mr. Blakely through a torrent of rain and took the train at 20.20 o'clock for Regina.

The following morning was taken up by examining the barracks of the North-west Mounted Police and the successful experiments in cultivating trees and growing flowers which have been carried on for many years by Col. Herchmer. It is very seldom that one can see anywhere such beautiful sweet peas and other annuals, and as well grown vegetables as are produced at Regina in these grounds. A most successful meeting took place in the afternoon at which many prosperous farmers from the surrounding country, as well as several government officials, were present. A vote of thanks to the speakers was proposed by His Honour the Lieutenant Governor, and seconded by Mr. D. J. Goggin, the Superintendent of Education.

The next meeting was at Moose Jaw, and I was much pleased to have an opportunity of driving out both in the morning and in the afternoon to see the grand crops which are now being grown in this semi-arid district, and are due to the recent adoption of the best methods of farming for that section of country. The discussion at the meeting held in the afternoon was mainly upon the treatment of such annual weeds as the various kinds of mustard, several of which were prevalent through the district, the Spear-leaved Goosefoot *(Monolepis chenopodioides*, Moq.*)* and of such deep-rooted perennials as the White-stemmed Evening Primrose, Poverty Weed *(Iva axillaris*, Pursh*)*,

known here under the appropriate name of Smother Weed, and the Blue Lettuce (*Lactuca pulchella*, DC.).

Early on the morning of June 29 I left Moose Jaw with Mr. Blakely, and having been joined at Regina by the Hon. Mr. Bulyea, went on to Wapella, where a team was in readiness to take us to Fairmede, 18 miles distant, at which place we held the first of several successful meetings away from the railway, driving from place to place through the country. We were all much surprised at the fine agricultural hall and buildings at Fairmede, but this was soon explained by the prosperity of the farmers in this fertile district. We spent the night at the comfortable home of Mr. John Kidd, who moved out west from the Ottawa district many years ago.

The next meeting was at Glen Adelaide, 22 miles distant, and was reached after a delightful prairie drive in the afternoon. We spent the night at Cannington Manor, and leaving the next morning, were driven by Mr. McDiarmid, M.L.A., through the Moose Mountains and White Bear's Reserve, passing by Heart Hill, one of the highest mounds of these hills, to Arcola (16 miles), where we were hospitably entertained by Mr. J. L. Thompson. Mr. Thompson's farm lies at the foot of the Moose Mountains, with a magnificent stretch of level and extremely fertile land lying to the south of it. The prosperity of this section is clearly shown by the fine houses of the settlers, notwithstanding the long distance over which all produce has to be driven to market or to the railways. In the afternoon Mr. Thompson drove us 7 miles to the new village of Clare, where a meeting was held. A few farms in this district were found to be infested with Stink Weed (*Thlaspi arvense*, L.) and Hare's-ear Mustard [*Conringia orientalis*, (L.) Andrz.], which had been accidently introduced a year or two before, but which had been recognized and were being attended to. The Shepherd's Purse (*Capsella Bursa-pastoris*, Mœnch) and the Green Tansy Mustard (*Sisymbrium incisum*, Engelm., var *filipes*, Gray.) were also remarkably abundant in one or two places, and both plants were seen to be loaded with seeds. At the meeting stress was laid upon the importance of early summer-fallowing and of mowing down all weeds with ripe seeds before the summer-fallows are turned down. We afterwards drove back to Arcola with Mr. Thompson and remained with him until the morning of Monday, July 3.

Leaving at 8 o'clock on July 3, we drove 10 miles to Carlyle, where a large meeting was held in the afternoon, and subsequently 23 miles further to Alameda, on the Souris Branch of the Canadian Pacific Railway, where we were joined by Mr. Trant, and a splendid meeting took place in the afternoon, at which a great number of specimens were brought in by farmers and where there was a most useful discussion. After this meeting we walked to Oxbow, the next station along the railway, passing through the rich lands lying along the Souris River. As we neared the town of Oxbow, we found some crops of wheat in which the Prairie Rocket (*Erysimum asperum*, DC.) was very abundant, and, being such a conspicuous plant, it had naturally caused considerable anxiety among farmers who had recognized it as a member of the Mustard Family. This plant, however, is a biennial which seldom shows itself as abundantly as was the case this year, being a native plant which has never proved to be an aggressive crop pest and which besides is easily pulled up, the large plants never growing very closely together; it is not likely, therefore, to develop into a bad weed.

The meeting at Oxbow was equally successful with the preceding one. The next morning we drove to Carnduff, where we were joined by Mr. T. N. Willing. The farmers here were found to be much interested in the weed question, and the same was the case at the meeting held on July 7 at Gainsborough, many pertinent questions being asked and much interest being taken in the Hon. Mr. Bulyea's efforts to assist the farmers. From Gainsborough a 25-mile drive brought us to Melita on the evening of July 7. Here I finished my work for the North-west Government—three weeks of delightful travelling, in which a large tract of country quite new to me was traversed and in which I had enjoyed many opportunities of studying the insects and plants of the country passed through. I must here express my gratitude to the Hon. Mr. Bulyea for frequent modifications in his plans, which I know were made entirely on my account, so that I might see as much as possible of this interesting country and have every convenience to collect plants and insects, noxious and beneficial.

Manitoba.

On July 8, in accordance with an agreement with the Manitoba Government, I went to Elkhorn, Man. and addressed a meeting of the Elkhorn Farmers' Institute. I remained at this place till the following day, when I took the train back to Winnipeg to assist in the arrangement of the exhibit of the noxious weeds of Manitoba, shown in the Weed Tent of the Provincial Government of Manitoba at the summer Industrial Fair. This exhibit was an unqualified success. Almost every kind of the noxious weeds of the province was shown, plainly labelled with its English and scientific names, and at all times of the day some officials of the department were in attendance to give such information as might be desired by the thousands of farmers who visited the exhibit every day from early morning till late at night.

British Columbia.

On the morning of July 13, I left Winnipeg and proceeded westward to British Columbia by way of the Crow's Nest Pass, visiting the thriving and active towns of Nelson and Rossland on the way. I reached Vancouver on July 19, when I joined Mr. J. R. Anderson, the Deputy Minister of Agriculture for British Columbia. The afternoon was spent in admiring the colossal trees and other plants in Stanley Park. On the morning of the 20th New Westminster was visited, and we reached Victoria the same evening. The 21st was spent in the Department of Agriculture, examining the collections and answering correspondence forwarded from Ottawa. In the evening we went out by special train to South Saanich, where a largely attended meeting of the Victoria Farmers' Institute was held; the subjects treated of at this meeting were weeds of the farm and injurious insects. We returned to Victoria the same night, and on the morning of July 22 left for Duncan's, on the Esquimalt and Nanaimo Railway. We were met at the station by Mr. G. H. Hadwen and driven out to his fruit farm. We returned to Duncan's for a meeting of the Farmers' Institute held in the afternoon. The subject of main interest at this meeting was Hay and Pasture Grasses. Noxious Weeds and Agricultural Education were also discussed at some length. After the meeting a visit was paid to the grounds of Mr. W. C. Duncan to examine a patch, which he had had under cultivation for many years, of *Bromus virens*, Buckl. (*B. Hookerianus*, Thurb.), a grass of much promise closely resembling the Southern Brome grass (*Bromus Schraderi*, Kunth). We returned by the evening train to Langford and drove to a meeting of the Metchosin Farmers' Institute. This meeting had been well advertised and was largely attended. After the meeting we drove back to Victoria reaching there at 1.30 a.m.

On Monday morning, July 24, in company with Mr. Anderson, I started for the interior of Vancouver Island; we arrived at Nanaimo about noon and were joined by the Rev. G. W. Taylor, of that place. After lunch we drove 36 miles to Mr. R. F. Hickey's, at French Creek, and later in the evening back to McCarter's Hotel, where an evening meeting was held. This day's journey was full of interest on account of the wonderful forests with which this part of the island is clothed. Objects of great wonder were the enormous trees of *Arbutus Menziesii*, Pursh, many of them over 2 feet in diameter and some large specimens reaching even 3 feet. The next morning we started at 6 o'clock and drove 30 miles to Alberni, arriving there at 3 o'clock in the afternoon.

The drive past Cameron Lake and around the foot of Mount Arrowsmith is one of the most remarkable drives I have ever taken—the road magnificent, smooth and well gravelled the whole way, and through a most wonderful forest, a tract of two miles just past Cameron Lake on the Alberni side, particularly shows the Vancouver Island forests in perfection: gigantic Douglas Spruces, Hemlocks and Cedars—specimens of these trees from 6 to 8 feet in diameter being found by thousands—growing so close together, only 30 or 40 feet apart, that the straight trunks rise up over 100 feet before a branch is reached. The heads of these giants seem very small compared with their towering trunks. The undergrowth beneath these trees is remarkably sparse and consist almost entirely of mosses and ferns, with the beautiful and fragrant *Achlys triphylla*,

DC. The woods the whole way are characteristically mountain woods. The Salmon Berry (*Rubus spectabilis*, Pursh) with its luscious fruit, like enormous orange or maroon-coloured raspberries, was in full fruit, also the Red-berried Vaccinium (*V. parvifolium*, Smith), a most beautiful shrub with bright red fruit like yew-berries, borne singly and produced in such quantities as to bend down the slender branches. A noticeable feature along the road was that many introduced grasses and weeds were abundant which had been brought in either by the road-makers or in carrying hay over the road.

A meeting was held at Alberni in the evening and the following morning we started at 4.30 and drove back 30 miles to Little Qualicum, where we caught the steamer *Thistle* and went to Comox, reaching there at five o'clock in the afternoon. Thence we proceeded at once to Courtney, where we passed the night. The next morning an interesting drive was taken to the mining town of Union and to a beautiful lake three miles beyond. The heat was excessive, but a good meeting was held in the evening, the addresses being followed by animated discussions, the so-called Canada Thistle being the principal subject.

On the morning of July 28 we left by the 7.30 steamboat and reached Nanaimo at five o'clock in the afternoon and started at once with the Rev. G. W. Taylor for Cedars, where a small but enthusiastic meeting was held in the evening. We then returned to Nanaimo for the night. A meeting was to have been held at Salt Spring Island on Saturday the 29th, but we found that the steamboat had been taken off for some excursion, and it was impossible for us to reach the island. We therefore returned to Victoria and remained there until Sunday night, when we took the eleven o'clock steamboat for the mainland. Vancouver was reached by eight o'clock and New Westminster at eleven; we then took the steamer for Ladner's Landing, where our first meeting on the mainland had been advertised. Leaving Ladner's at five o'clock the next morning, we drove back and took the steamer opposite New Westminster for Langley. A good meeting was held in the afternoon, after which we proceeded by canoe to Port Haney and from that place walked to Hammond, where we passed the night. The next morning we took train for Abbotsford, where an informal meeting of farmers was held. In the evening we returned to Mission Junction, and the meeting at night was one of the best of this series, being well attended and much interest shown in the subjects discussed. On the morning of August 3, I walked to Hatzic with Mr. Tom Wilson, a member of the Provincial Board of Horticulture, and examined several fine orchards, many of which, however, were seriously injured by the attacks of the Pear Slug, against the injuries of which no steps seemed to have been taken. From Hatzic we proceeded by steamer to Chilliwack, where a most successful meeeting took place. Chilliwack is one of the most favoured spots in British Columbia and the meetings, being always well worked up, are invariably satisfactory. On the afternoon of the 3rd we drove out to inspect a currant plantation belonging to Mr. Ford, which was heavily infested by a downy scale insect, *Pulvinaria occidentalis*, Ckll, the western representative form of the well-known eastern Cottony Maple Scale, *Pulvinaria innumerabilis*, Rathvon. Leaving Chilliwack on the morning of the 4th, we reached Agassiz before noon. The afternoon was spent in examining critically the pastures of the Experimental Farm with a view to discover if possible any plants which might be the cause of the disease among cattle known as 'Red Water.' Nothing of importance was discovered, and none of the plants reputed to be the causes of this obscure disease were found in undue abundance, nor could it be seen that any of those which did occur had been eaten by stock which had fed there. A very successful meeting of the Farmers' Institute was held in the evening. This was well attended and was followed by a protracted discussion. In addition to Mr. Anderson and the writer, Mr. Thomas Sharpe delivered an address.

Starting at 4 o'clock on the morning of August 5, an expedition was made to the summit of Mount Ché-am for the purpose of collecting botanical and entomological specimens. We were accompanied by Mr. Allan Brooks, an enthusiastic ornithologist, and one guide, Jim Harris, a Ché-am Indian from Popcum, well acquainted with the mountain and an experienced climber, who was of great service to us. Notwithstanding the lateness of the season and the exceedingly unpropitious state of the weather which prevailed while we were on the mountain, we made large and valuable collections

both of plants and insects. As a result of the late season, we found on the summit banks of snow 75 and 100 feet deep, where last year at the same date we had seen deep ravines. On the morning of August 8, it began to rain at 6 o'clock, so we decided to descend at once, and at eight o'clock struck camp and began the descent of the mountain in a downpour of rain, which continued all day till we got to the base at 16 o'clock, drenched to the skin, but with all of our specimens safe, as we had wrapped them in waterproof covers before starting. At Popcum we took a hasty meal and crossed the Fraser River by 17.30 o'clock. The following morning was fully taken up attending to our specimens and in drying our clothes to be ready to leave for the upper country on the train at 15.47 o'clock.

We reached Sicamous on Shuswap Lake at 2.35 o'clock and waited there in pouring rain till 6 o'clock, when we took the Okanagan Valley train for Armstrong, arriving there at 9 o'clock. We had hoped to have collected many specimens in this locality, but it rained all day. Our time, however, was by no means wasted, for we examined a very interesting local collection of plants and insects made by Mrs. Walton, of Armstrong, and in the evening held one of the best meetings of our whole trip. This was of the Spallumcheen Farmers' Institute. Some of the worst weeds of the North-west, including the Tumbling Mustard, False Flax and Ball Mustard, were found to have gained a foothold in this fertile valley, and the farmers were keenly interested in learning all that was to be known about them. The Prickly Lettuce (*Lactuca Scariola*, L.) and the Purslane (*Portulaca oleracea*, L.), both of gigantic dimensions worthy of the Pacific Province, were brought to the meeting. We left Armstrong at 9 o'clock on the morning of August 11, for Okanagan Landing, where we took the fine steamer *Aberdeen* for Kelowna, and reached there at 16 o'clock. After being shown over the new and up-to-date factory of the Kelowna Shipper's Union, where the now well known 'Flor de Kelowna' cigars are made, we were driven out to see the surrounding country by Mr. J. T. Davies, the President of the Okanagan Farmers' Institute. We first visited Lord Aberdeen's ranche at Guisachan, where we were shown fields of Smooth Brome grass. We then visited the extensive and successful tobacco plantations of Messrs. Collins and Holman, and finally accompanied Mr. Davies to his own home. The meeting at Kelowna was held at 20 o'clock in the evening and was, as is always the case at this bright active little town, well attended and very successful. We left this delightful place at noon on August 12 and reached Enderby at 18 o'clock the same evening; there we left the train and drove across the country to Salmon Arm, arriving at 20.30 o'clock, just in time for the meeting of the Salmon Arm Farmers' Institute. This meeting, although not so largely attended as those at Armstrong and Kelowna, was full of interest, as this place is becoming a fruit growing centre of importance in the province. The addresses were attentively listened to and fully discussed.

This was the last of a series of sixteen useful and most enjoyable meetings held with Mr. Anderson in the best agricultural and fruit growing districts of British Columbia. Mr. Anderson's thorough knowledge, not only of the capabilities of his province, but also of its fauna and natural history, made him a most entertaining companion; the careful arrangements he had made beforehand enabled me to take the fullest advantage of the expedition, which was of inestimable value to me in becoming acquainted with the conditions prevailing in the various localties visited, so that I might be of as much use as possible in the future to such farmers of British Columbia as may wish to correspond with the Division of Entomology and Botany.

We left Salmon Arm at 1.25 o'clock and reached Banff, Alta., by 17 o'clock on August 13. I remained there until the next day, when in company with Mr. W. C. McCalla of St. Catherine's and Mr. N. B. Sanson, Curator of the Government Museum at Banff, both enthusiastic botanists we sallied out, and, notwithstanding the torrents of rain which fell almost continuously, I added several desirable botanical specimens to my collections. On August 14, I left for home at 16.10 o'clock, reaching Winnipeg at 21 o'clock on the 15th, and Ottawa at 18 o'clock on August 17.

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AUTHOR'S EDITION
FROM ANNUAL REPORT ON EXPERIMENTAL FARMS FOR THE YEAR 1900

CANADA

DEPARTMENT OF AGRICULTURE

CENTRAL EXPERIMENTAL FARM

REPORT OF THE ENTOMOLOGIST AND BOTANIST

(JAMES FLETCHER, LL.D., F.R.S.C., F.L.S)

1900

OTTAWA
GOVERNMENT PRINTING BUREAU
1901

REPORT

OF THE

ENTOMOLOGIST AND BOTANIST.

(JAMES FLETCHER, LL.D., F.L.S., F.R.S.C.)

1900.

OTTAWA, December 29, 1900.

Dr. WM. SAUNDERS,
Director of Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to hand you herewith a report on some of the more important subjects which have been brought officially before the Division of Entomology and Botany during the past season. Owing to the large increase in correspondence and the numerous species of insects and plants inquired about, it has been somewhat difficult to decide what subjects could be most usefully treated of in the present report. I have prepared articles upon those subjects concerning which I thought information would be of most service to the farmers, fruit-growers and gardeners of Canada.

Since the fitting up of a new room for the exhibition of specimens, many visitors to the Central Experimental Farm have availed themselves of the opportunity of consulting the collections which are now being gradually arranged and put into shape for reference. Many valuable additions have been made during the year to both the entomological and botanical collections.

Considerable progress has been made in the studies of the life-histories of our native insects, both noxious and beneficial, and a fine collection illustrating all stages of their development is being gradually accumulated. During the past year many specimens of inflated caterpillars have been prepared by Mr. Arthur Gibson, assistant in the Division, and are much admired by visitors.

The experiments in growing grasses and other fodder plants have been continued and are of great interest.

The Apiary, as heretofore, has been looked after by Mr. John Fixter, the farm foreman, and his report on that branch of the division work is printed at page 243.

Correspondence.—From November 30, 1899, to November 30, 1900, the number of letters, exclusive of circulars, received by the Division, was 3,017, and the number of letters despatched was 2,847.

Meetings Attended.—Meetings of farmers, dairymen, fruit-growers, &c., have been attended whenever official duties would allow of my absence from Ottawa. Addresses were delivered at the following places : Granby, Que., February 20 and 21 ; Cowansville, Que., March 14 and 15 ; St. Catharines, Ont., March 20 ; Danville, Que.,

September 5; Niagara Falls, Ont., December 5 and 7; London, Ont., November 13, 14 and 15, attending the annual meeting of the Entomological Society of Ontario. Meetings have also been attended and addresses delivered before the Toronto and Montreal branches of the Entomological Society, and also before the Toronto and Ottawa Normal School students on nature study. In June last on account of reports received from Manitoba of serious depredations on crops by locusts, and at the request of the Provincial Minister of Agriculture, I was instructed by the Honourable the Minister of Agriculture to proceed to Manitoba and investigate the matter. Accordingly, on June 21 I left Ottawa, and, having joined the Chief Clerk of the provincial department at Winnipeg, visited some of the worst affected districts. This matter is reported upon later on.

In response to a request to the Minister from the government of the North-west Territories, I then went on to Regina and joined the Hon. G. H. V. Bulyea and, in company with him and Mr. Angus Mackay, the Superintendent of the Experimental Farm for the North-west Territories, went to the Prince Albert district and held a series of farmers' meetings. Addresses were delivered upon agricultural subjects with special reference to the control and eradication of noxious weeds. These meetings were very successful, and the country traversed—a circuit of about 200 miles through a country of great fertility—was of extreme interest. Leaving Prince Albert on July 7, where the first meeting was held the previous day, we drove east and south and held meetings at Colleston, July 7, Melfort, July 9, Kinistino and Harperview, July 10, St. Louis, July 11, Lindsay and Willoughby, July 12, Rosthern, July 13, and back to Duck Lake on the railway on July 13. A supplementary and very largely attended meeting was held at the request of Mr. Wm. Traut, at Lumsden, twenty miles from Regina. Several excellent farms were examined en route and much valuable information as to the nature of the country and its suitability for various crops was acquired, which will be of much use to me in the future.

Acknowledgments.—My special thanks are gratefully tendered to the following for frequent and valuable assistance: to Prof. John Macoun, of Ottawa; Prof. J. B. Smith, of New Brunswick, New Jersey; Dr. L. O. Howard and Messrs. B. T. Galloway and A. F. Woods, of Washington; Prof. F. M. Webster, of Ohio, and Mr. G. B. King, of Lawrence, Mass., for identification of specimens, and also to Prof. C. C. James, Deputy Minister of Agriculture for Ontario; Mr. J. R. Anderson, Deputy Minister of Agriculture for British Columbia, and Mr. Hugh McKellar, Chief Clerk of the Department of Agriculture for Manitoba, for prompt notification of outbreaks of injurious insects. To Mr. R. M. Palmer, Inspector of Fruit Pests for British Columbia, and the Rev. Father Burke, of Alberton, P.E.I., I am indebted for reliable reports on insect injuries and the condition of the crops in their respective provinces, all of which have been of great service to me in making the work of the division under my charge useful to the farmers of Canada.

In conclusion I have much pleasure in testifying to the assiduity and excellence of the work performed by my assistants, Mr. J. A. Guignard, B.A., and Mr. Arthur Gibson, in office hours or afterwards whenever required.

I have the honour to be, sir,

Your obedient servant,

JAMES FLETCHER,

Entomologist and Botanist.

INSECT PESTS.

THE HESSIAN FLY
(Cecidomyia destructor, Say*)*.

A serious outbreak of the Hessian Fly in the fall wheat fields of western Ontario during the past season has to be recorded. There was some appearance of the summer brood in the same districts, but only a few references were made to the insect, until it was found that the new crop of fall wheat was infested to a degree which has seldom been seen in Canada for many years. The district where the greatest harm was done, was in the area lying to the west of Lake Ontario, and north of Lake Erie.

Fig. 1.—The Hessian Fly—enlarged and natural size.

Prof. Lochhead, of the Guelph, Ontario, Agricultural College, writes as follows :—

'Guelph, December 22.—The Hessian Fly is very general in Essex, Kent, Elgin, Norfolk, Haldimand, Lincoln and Middlesex ; it is reported from various parts of Welland, Lambton, Huron, Oxford and Brant. Occasional mention is made of it in Perth and Simcoe. Practically none is reported from Bruce, Grey, Wellington, Waterloo and Dufferin. The eastern half of the province is practically free from the Hessian Fly. (The above information was obtained chiefly through the reports of the Bureau of Industries.) Professor Pettit, of the Michigan Agricultural College, writes me, December 1, that this year all early sown wheat, and, in fact, all wheat sown before October 1, is infested, some of it badly. This is the case over a great part of the state. In ordinary years the third week in September is late enough to sow wheat to escape the fly, and we should not, I think, make our deductions from two such unusual years as the last were.'

'Brantford (Brant Co.), Ont., August 3.—The Hessian Fly has been bad in this neighbourhood this season. How late should I sow my wheat in order to escape the fly altogether ? Would there be any use in sowing as small a plot as half an acre on a fifty-acre farm, to act as a trap, if no neighbour sowed any wheat extra early ? What would be the best date to sow ?'—T. F. Howell.

'Waterford (Norfolk Co.), Ont., Nov. 7.—The Hessian Fly seemed to injure the sample of wheat this year by preventing some of the grain from maturing. Late sown fall wheat seems rather free this autumn, but that sown early seems to be in some cases so badly infested that farmers are talking of ploughing it under.'

'Waterford (Norfolk Co.), Ont., November 29.—I have found two fields quite close together which are affected by the Hessian Fly. The grower, Mr. James Clark, states that both fields were sown from 15th to 23rd September. In one, a field of Clawson wheat, I believe that 80 per cent of the plants contain Hessian Fly puparia, and in the other field, of Democrat wheat, about 30 per cent. You will notice from the specimens sent that the Clawson plants affected show the upper and earlier sprout generally killed, but there is an uninjured sprout growing up from the original seed. The Democrat variety, on the other hand, shows that the insect has not injured the original sprout to so great an extent, and, consequently, this second sprout from the seed has not made its appearance in so many cases as in the Clawson. With respect

to the appearance of the two fields, the Democrat looks quite green, healthy, and apparently uninjured, but the Clawson appears wilted and not nearly so green. The difference in favour of the less injured field was very noticeable. About November 8, I found no larvæ in the fields; all had changed to flax-seeds. This fall has been very remarkably free from early frost.'—N. H. COWDRY.

'Belmont (Middlesex Co.), Ont., December 4.—Fall wheat has been considerably injured in this section by Hessian Fly. Feeble wheat on poorly-prepared ground is very badly injured, portions of it being entirely killed out. Most of the wheat turned yellow, more or less, during October, owing, I think, partly to the unseasonably warm weather, causing rust to develope. Since receiving your letter, I have carefully examined many fields of wheat, and am convinced that all the damage was not done by Hessian Fly. Wheat that has a bulky vigorous growth promises to give a fair crop next year, as the stools have many comparatively sound and healthy shoots left; after feeding the fly, they had a lot of vitality and substance remaining, but badly nourished wheat had little or nothing left after the flies had fed on them, and they are now dead, or nearly so. The summer brood did considerable damage here, both to wheat and barley. I am satisfied that the fly cut me short 100 bushels on 27 acres. Heavy crops of wheat were hardly touched by the fly; but, where the wheat was winter-killed, or otherwise weakened and thin, it did a lot of damage. Many farmers held off their sowing this year to escape the fly, but this, I think, is a mistake. Late wheat will be weak and more liable to winter-kill, and for this reason will fall a more easy prey to the summer brood next year. I believe that if wheat is sown at the right time on rich and well-prepared land, it will get a vigorous, bulky growth in the fall, and will thus be able to withstand the attacks of both broods of the fly.'—H. PETTIT.

'Ferguson (Middlesex Co.), Ont., October 30.—Since reading Dr. Saunders's article in the Entomological Society of Ontario report for 1882, I have found that the suggestions there made concerning treatment for the Hessian Fly work very well. However, I have followed them again to the letter this year, working the land with the twin plough immediately after the crop was taken off, then ploughing after, and sowing from 17th to 24th September, and have now under wheat, ground that was previously sown to clover, barley, oats, and a small piece of wheat. The result in all cases is the same, the plants are full of Hessian Fly in all stages, from the tiniest mite to the flax seed state. I have also found another insect, a sort of buff colour, with legs and a proboscis, with which it probes the plants, and any plants that I have seen attacked are doomed. The Hessian Fly is so numerous this year that I have counted as high as fifteen clustered in one stalk. Yesterday, my interest in this subject being aroused, I inspected many fields which had been sown on or about August 31 up to September 29, and I find them all thoroughly infested, and to such an extent that I think the most advisable course will be to plough them under and sow a spring crop. You could do agriculturists a signal service by collecting evidence of the extent or area covered by this pest, and by giving the results publicly in the press, describing the habits of the fly, and particularly how often reproduction takes place. By doing this, farmers would be in a position to judge of the advisability of leaving their fields, or of ploughing up and resowing with oats or some other spring crop. It would also give them an opportunity to provide seed, which is at a late date, like spring ploughing, for instance, both difficult to get and often dear.'—JOHN C. WALLIS.

'Binbrook (Wentworth Co.), Ont., December 4.—I mail you to-day two samples of fall wheat, one sown on September 10, and the other September 13. They are both of the same variety, Long Amber. This is a fair sample of the wheat in Wentworth county.'—E. J. DUFFY.

The samples sent were found to be pretty badly infested with puparia of Hessian Fly. In the first parcel of 22 plants, 3 of them were crowded with flax seeds, but 19 were uninjured. In the second parcel, 12 were infested and 14 uninjured.

'Waterford (Norfolk Co.), Ont., December 3.—In the townships of Townsend and of Windham, the Hessian Fly will nearly ruin the whole wheat crop. My wheat is half dead now, but some of it has started up from the root again. I have counted as many as nine flax seeds on one stem. I sowed my wheat on September 19 and 20. I do not think there will be half a crop of wheat. Some farmers sowed earlier and some later, but their wheat is as bad as mine.'—WILLIAM SCHRAM.

Every plant sent with the above letter was heavily infested, and the roots were apparently quite dead, with no appearance of new shoots being thrown out, as in the case of the plants sent from the same place by Mr. Cowdry.

'Glencoe (Middlesex Co.), Ont., December 4.—The fall wheat is so badly killed that there is very little left. There will be hardly a field left by spring. I sowed my first wheat on September 14, and on the 18th I sowed another field. The field I sowed last is the worst I have, but it is a weak growing variety called Kansas Turkey Red. All the rest of my wheat is Dawson's. One of my neighbours sowed September 1; all is gone. Another sowed on October 1, and this is not affected so far as I can see, but it did not make much top. I was about 40 miles west from here, and I saw a great amount of the wheat affected. Some was not up which was sowed very late. I sowed a field for one of my neighbours on September 19 on a gravelly loam. There is not a single green leaf left in the field. I notice that there is a little more greenness on the heavy clay than on the loam, gravel or sand. We had no frost until very late this year.'—JAMES GLASGOW.

The samples sent by Mr. Glasgow were all badly attacked, and about equally, by the Hessian Fly (every specimen of which was in the flax-seed state) and by the Wheat-stem Maggot (*Meromyza americana*, Fitch), all in the larval state.

It will be seen from the above letters, which cover all the points brought forward in other letters, that there are two features about this year's attack by the Hessian Fly which are unusual. In the first place, the severity of the outbreak, accompanied by a remarkable number of puparia in each stem, and the late date at which the flies were active and laying their eggs this autumn, thus necessitating at least a delay of one week more beyond the usual date recommended for safety, viz., the third week in September, before it will be safe to sow fall wheat and have it free from the attack of this enemy. From correspondence and a personal investigation of the fields in the Niagara Peninsula made early in December, this year, it was apparent that late sowing was attended with very beneficial results. Owing to the open and mild autumn this year, it was possible to sow later than usual, and several fields sown in the beginning of October were much freer from attack than those which were sown at what was considered to be the proper time, namely, the end of August or the beginning of September.

For many years previous to 1899 the Hessian Fly has done very little harm in Canada to fall wheat, and as a result of a great many experiments which are being carried out every year by the members of the Ontario Experimental Union, and other progressive farmers, it had become well known that the best crops were reaped from fall wheat sown at or before September 1. This, therefore, had given rise to the opinion that the proper time to sow fall wheat was at or about the date mentioned. This, however, is only true in such seasons and localities as the Hessian Fly and Wheat-stem Maggot are not abundant; but in periods when these two serious enemies increase, as has been the case during the present season and last year, it will be found that the proper season to sow fall wheat and rye is subsequent to the time when the egg-laying females of the autumn broods of both of these insects have disappeared. For a year or two, at any rate, it will certainly pay farmers to acquaint themselves better with the life histories of these insects and the remedies which have been found successful in preventing the losses due to their attacks.

The life history and the remedies for the Hessian Fly have been frequently given in the reports of this Division, and were fully treated in last year's report, but it may be well here to again give a short synopsis of these.

Attack.—In autumn a few small whitish maggots, oval in shape, generally showing a green stripe in the centre, may be found in the root shoots of fall wheat. Later these harden and turn brown, when they resemble small flax seeds. During May and June of the following spring, the so-called Hessian Flies, small blackish midges, with smoky wings and about $\frac{1}{8}$ inch long, appear and fly to the fields of growing wheat, where they lay minute reddish eggs, singly or in small clusters, on the upper sides of the leaves. The young maggots, after hatching, work their way down inside the sheaths of the leaves and feed at the bases of the joints. The presence of the puparia, or flax seeds, can usually be detected by the breaking down of the stem at the point where these occur, owing to the weakening of the stem by the attacks of the maggots. The flies from this summer brood appear in September and lay their eggs upon the leaves of the young fall wheat. This is called the autumn brood, and is the one which has done so much harm this year.

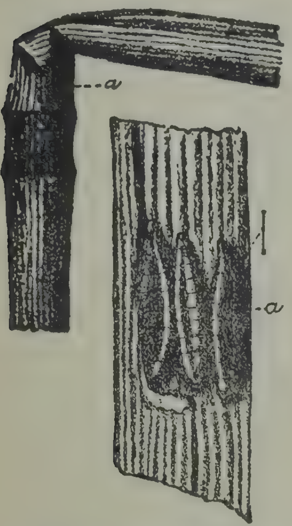

Fig. 2.—Hessian Fly; injured wheat-stem; three puparia enlarged.


Fig. 3.—Hessian Fly: puparia—natural size and enlarged.

Remedies.—1. Late Sowing.—The most important preventive remedy against injury by the Hessian Fly is the postponement of seeding until the end of September. By this means the appearance of the young plants above the ground is delayed until after the egg-laying flies of the second brood are dead. Where fall wheat has been sown in August, as is frequently done, the plants are well up and ready to receive the eggs of the flies when they emerge from the flax seeds of the summer brood. It is sometimes advised to feed off the green tops to a certain extent with sheep during the months of September and October, in which way it is claimed that many of the eggs are destroyed. I have never been able to prove that there is any advantage in this method other than giving a supply of good fodder at a time of the year when this is sometimes short. The chief objection to sowing so late as the end of September is that, as a rule, the plants have not time to make vigorous roots and tops so as to withstand the cold of severe winters. This, however, is seldom true, and in a great number of experiments, even at Ottawa, I have frequently found that good crops can be obtained from wheat sown much after the first of October, and while the Hessian Fly is abundant I believe that it is the very best policy for farmers to sow their fall wheat rather by the first of October than by the first of September, for although they may get a slightly smaller yield, it is better for them to be content with this and to be sure of it, than, in the effort to get a bigger crop, perhaps run the risk of losing half or even more from the attacks of the Hessian Fly. On this question of the proper time to sow fall wheat, the following from Prof. F. M. Webster, the State Entomologist of Ohio, who for a great many years has made a special study of the Hessian Fly, is of interest :—'I think the proper time for sowing fall wheat is late September. Early sown wheat will surely invite the attacks of the fly, and, while in years when this is not abundant the wheat may go into winter in better condition than that sown later, I believe that ordinarily this will not be the case. Your idea of choosing vigorous growing varieties and sowing late, on land prepared in the best possible manner is, to my mind, the right one. I think that in fall wheat the spring brood of Hessian Fly generally selects the younger tillers. I have observed in many cases that at harvest, what from appearances seemed to be tillers that had made the least growth in the fall, were attacked by the fly in the spring and another stem had been formed. Still, I do not think that any fixed rule can be laid down with regard to this. I believe that the Hessian Fly in spring will lay its eggs upon any stem or tiller that promises a good food supply for the young.'

2. Burning Refuse.—Many of the flax seeds of the summer brood are carried with the straw, and at threshing time are dislodged and fall down with the rubbish beneath the machine or are left in the straw. All dust and screenings should, therefore, be carefully destroyed, and all straw and small seeds should be either used during the winter or burnt before spring.

3. Treatment of Stubbles.—Most of the puparia of the summer brood are placed so low on the stems that they are left in the stubble when the wheat is cut. A large proportion of these give forth their flies in September, but some pass the winter in the stubble. An effective way to destroy these puparia is to plough down the stubbles deeply as soon as possible after the crop is cut, so as to place the insects so deep beneath the earth that the delicate flies, when they emerge, cannot reach the surface.

4. Trap Crops.—A method of reducing the numbers of the Hessian Fly, which is little practised, but which is spoken highly of by those who have adopted it, is the sowing of narrow strips of wheat in August, which will attract the females to lay their eggs, and which can afterwards be ploughed down. What is practically the same plan, is to run a harrow over fields as soon as the crop is cut, so as to start the volunteer crop from grain which has dropped in harvesting and induce a growth of wheat on the field sooner than otherwise would be the case.

5. Fertilizers.—When it is found that a young crop of fall wheat is only lightly infested, it is sometimes possible to stimulate the growth of the plants in spring by making a light application (so as not to cost too much) of some quick-acting special fertilizer such as nitrate of soda.

In cases such as we have many of in our fall wheat fields this autumn, where the attack is irregular in its occurrence, it will frequently be rather a difficult problem for a farmer to decide what his wisest course is. When, as is generally the case, there are patches in a field which have been destroyed, it is desirable to save such parts of the field as are uninjured. These patches can be sown in spring to some crop which will not require cultivation during growth, e.g., an early ripening barley, which can be cut at the same time as the fall wheat and the whole threshed as mixed feed. If, however, it is necessary to save the wheat separately, peas may be sown on these patches, and either the peas can be cut after the wheat, or the grain can be separated after threshing. In cases of bad infestation it would sometimes pay better to use the land at once for some other crop. It will, however, be necessary to replough the land deeply so as to bury the flax seeds too deep for the flies to get out, and then lay their eggs for the summer brood on spring wheat or the remnants of the crop of fall wheat. Unfortunately, the usual practice is merely to cultivate deeply, so as to produce a good seed bed. After reploughing, any crop may be sown except spring wheat. Barley and rye are also sometimes liable to attack, consequently other crops are preferable to barley or spring rye, such as oats, peas, corn or roots. There will also sometimes be cases when the farmer is uncertain what it is best to do, owing to the occurrence of uninjured patches in an otherwise badly infested field. In these cases, it will be best to wait and see how the wheat will turn out. If at last something else has to be substituted as a crop, probably the best returns will be obtained by sowing early-ripening corn, where a cultivator can be used, or early peas, where the patches are surrounded by wheat. Both of these crops may be sown as late even as the middle of June, and will usually give good results.

In the summer of 1899, as recorded in my last report, there was a remarkable outbreak of the Hessian Fly in the spring wheat crop throughout Manitoba, amounting to from 5 to 25 per cent of the crop. It is satisfactory to be able to record that there has been no recurrence of this outbreak during the past season. Mr. Hugh McKellar, Chief Clerk of the Department of Agriculture, writes under date December 18: 'I have much pleasure in advising you that this department did not receive any information this season, of the presence of the Hessian Fly in any part of the province.'

WHEAT-STEM MAGGOT

(*Meromyza americana*, Fitch).

Although the injury by this insect is not known to have been very serious during the past season, specimens have been sent in from a good many different places. It has been found attacking fall wheat in western Ontario in company with the Hessian Fly. The larger number of complaints and inquiries have come from Manitoba, and the North-west Territories, where the 'dead heads' caused by the summer brood had attracted attention and were thought by many to be the work of the Hessian Fly. The remedies for the Wheat-stem Maggot are practically the same as those for the Hessian Fly.

THE WHEAT-STEM SAW-FLY

(*Cephus pygmaeus*, L.).

This insect was reported from a few places in the North-west Territories during the summer of 1900, but no widespread injury was attributable to its attacks. Specimens were sent in from three places, and I have to thank my correspondents for taking a great deal of trouble in securing specimens and information concerning this interesting insect, which in any year may develop into a serious pest. A pretty full account of the insect and its life history was given in my report for 1896, when the most serious attack which has yet been recorded in Canada, was reported upon. This was at Souris, Man., on the farm of Mr. William Wenman. Mr. G. S. Tuxford, of Buffalo Lake, near Moose Jaw, Assa., has reported every year since then on the occurrence of the insect, and this year reports a serious outbreak, as follows :—

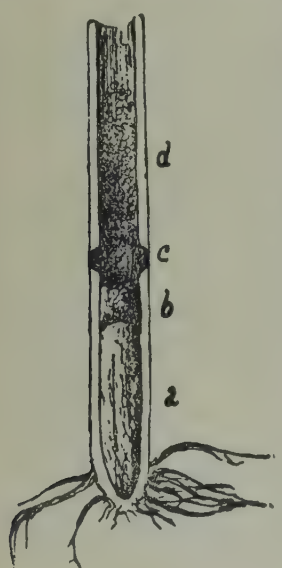

Fig. 4.—Wheat-stem Saw-fly ; *a*, cocoon; *b*, borings.

'Buffalo Lake, Moose Jaw, August 9.—Last summer I wrote you that there was not much sign of the Wheat-stem Saw-fly. Later I had to write again saying that some fields were rather badly attacked. This year, in our immediate neighbourhood of Buffalo Lake, the pest is assuming very serious proportions. We have just started wheat-cutting, and some fields especially all along the outside have from 20 to 40 per cent cut off and lying down. Our grain is ripening very rapidly this year ; a great deal is dead ripe now. We had four heavy rains on the 5th, 6th, 7th and 8th instant. Crops are from good to very good, though some fields sown on stubble will not give more than ten bushels to the acre.'

'September 18.—I have been trying to find some more stubbles in which the grubs of the Wheat-stem Saw-fly were hibernating ; but, owing to the early harvest, the late date of your request, and the many heavy rains, I find after many searches that it is impossible now to find any. At the end of July and early in August, it was very easy to trace and unearth the grub. I am sending you, however, a number of samples of the cut-off stems and heads. This is the same pest I complained of in the fall of 1897, and of which I then sent you samples. I remember you then advocated as one remedy, burning the stubbles in the fall. As the grub retires below the surface, would not this still leave it untouched ? It would be very difficult to get over a large area of ground by fall ploughing out here where the fall is so short.'—Geo. S. Tuxford.

It will be remembered that all wheat in the North-west is spring wheat.

The early date at which this wheat was ripe, August 9, was doubtless due to the dry hot season. This also accounts for the small yield mentioned by Mr. Tuxford, of fields sown on stubble. The advantage of sowing on land summer fallowed, as a means of retaining moisture, was very marked in the West last season. The injury by insects to an infested field being most severe on the outside, is not an unusual

circumstance and merely shows the readiness with which flying insects settle down and deposit their eggs when suitable food for their young is found.

The work of the larvæ inside the stems sent from Buffalo Lake was plainly noticeable, and the Wheat-stem Saw-fly was undoubtedly the cause of the stems being cut off.

As pointed out by Mr. Tuxford, the larva does burrow down very deeply into the base of attacked stems ; but I think that the burning over of stubbles will be found a very useful remedy against this insect. Fall ploughing in most seasons in the West is difficult, owing to the lack of moisture; but where the Wheat-stem Saw-fly has been abundant, it is important that wheat should not be sown on stubble land unless a good burn has been secured, and if possible the land should be ploughed deeply either in fall or spring. Summer fallowing every other year as is done by many farmers at Moose Jaw, and doing the work early, before the middle of June, will do much to control this insect.

'Cottonwood, Assa., August 13.—Can you tell me the cause of my wheat being cut down in this way? As you notice, it is fully ripe. It was grown on summer fallow. We have had heavy rains lately, which probably accounts for so much being broken down. I shall be grateful for any information which will help me to destroy this grub.'

'August 31.—I undertook the search for the specimens you asked for, this afternoon, and although there were any number of cut-off wheat stems scattered on the field it was difficult to locate the lower end, as nearly all seemed to be gnawed off at a level with and sometimes below the ground.'—HAROLD D. BUCHANAN.

The wheat here referred to was injured by the larvæ, and was merely broken off by the wind and rain. The stems were cut off mostly at the surface of the ground, and the larvæ would have been destroyed in these instances by burning over the stubble.

'Osler, Sask., August 7.—In searching for more specimens of the swollen stems which we have been communicating about, I found to-day one fallen straw in which there was a small worm about ⅜th of an inch in length; it was at the broken point, but immediately below the joint, with no appearance of a swelling on the stem. I think this is a different trouble from that which causes the swollen stems.'

'September 15.—I was much interested to hear that you had found a specimen of the Wheat-stem Saw-fly larva in the wheat straw I sent. However, I do not think it can be at all prevalent here; for, while searching around so much for the swollen stems which I sent you at the same time, this was the only specimen I found which showed any trace of the work of an insect.'—PERCY B. GRANT.

Remedies.—The means which are to be recommended for checking the increase of the Wheat-stem Saw-fly are : The burning over or ploughing deeply of all stubbles, also burning of such straw as is not used by the following spring, and summer-fallowing in June every other year.

Undoubted specimens of Wheat-stem Saw-fly were sent with the above letters, but some other correspondents who wrote of this insect were mistaken as to the identity of the insect they complained of.

INJURIES TO WHEAT DUE TO WEATHER.

There were several curious conditions of wheat in the West last season, which can only be accounted for by unusual climatic conditions, chiefly the excessive drought, accompanied with great heat and bright sunshine in the last days of June. The ears of wheat were scalded just as they emerged from the sheath or just inside it. Shade trees which had been planted for several years were also severely injured by this unusual heat. The thermometer along the Canadian Pacific Railway through Manitoba and westward as far at any rate as Regina, registered 98 to 106 and 107 degrees Fahr. in the shade on the three successive days June 28, 29 and 30. Spruce trees

planted at various places were turned chocolate brown on the sunny side in one day, and many kinds of plants suffered severely. The injury to wheat was curiously local, but I cannot discover any other possible reason for the aborted and scalded heads in some places. Very interesting specimens were sent in by Mr. Geo. Wise and Mr. W. S. Wallace, of Shellmouth, Man., with a complete account of the injury and its occurrence on various soils and under different exposures. The affected area was eight miles long, north and south, and one mile wide. The injury to the ears was such that no theory could satisfactorily account for it, the ears being blighted and shrivelled up, sometimes at the tip, most frequently at the base, five or six florets being whitened and empty, and sometimes in the middle, with good grain forming at the base and at the tip. Frost and heat would either of them account for some of the characteristics, but not all. The injury lasted a very short time, and the chief peculiarity was that in adjoining fields grain at the same stage and apparently under exactly the same conditions was uninjured. Another curious distortion of stems of wheat plants was shown to me at Osler by Mr. Percy B. Grant, in which the stem was swollen, hardened and thickened, and as a rule bent rather abruptly so as to burst the sheath just above the top node of the stem. This attack resembled closely the work of the Joint-worm *(Isosoma).* Mr. Grant wrote after considering the matter carefully and examining many specimens: 'My opinion of the matter is that the trouble is an excessive growth induced by the moist weather which came after a prolonged period of exceedingly dry weather.' I quite agree with Mr. Grant in this opinion, and so also do other botanists to whom I have shown the specimens.

'Osler, Sask., September 5.—I am sending you to-day a bundle of about 20 more or less injured stems ; all of these I cut off as near to the ground as possible, and all were standing except those which had broken at the injured points and fallen over. They show the swelling of the stem in various stages. I never saw this injury to wheat until this summer. Beginning with the middle of the month of June we had a spell of exceedingly hot and dry weather; the heat and drought gradually increasing till the end of the month, when nearly all the grain was out in head, although the straw was only from 6 inches to a foot high. Large patches of stubble land were materially injured by the want of moisture and, had the drought continued much longer, the bulk of the crop would have been ruined. However, about July 1, heavy rains set in, and there was an excess of moisture for nearly all the month. There was plenty of warmth in the ground, which, together with the moisture, pushed forward the growth at a rapid rate. The injured fields recovered rapidly, and those which had held their own during the dry spell sent up a rank growth. About a week after the rains began, numbers of the wheat stems were noticed to be lodged. The lodging continued for about a week and then stopped. The amount was variously estimated from one-twentieth to one-tenth, according to the field, being worst on new land (breaking) and least on summer fallow. The lodging was worst in the rankest spots of any particular field. It was always the largest stems with the largest heads which lodged. On closer examination, I found large numbers of stems still standing with the stems much swollen above the joints, and I noticed that the lodged stems were also swollen and had broken at the most distorted point. The swelling sometimes spread several inches up the stem, but in most cases was confined to one point until the stem bulged out so much that the sheath was burst and the inner stem protruded so much as to bend almost at a right angle, when it broke and was blown over by the wind. I found no lodged stems which did not show the swelling. The swollen stems which did not lodge were perhaps a little later in maturing than the rest of the crop.'—PERCY B. GRANT.

CUTWORMS IN WHEAT.

There was rather a serious outbreak of some kind of cutworm which attacked wheat fields in Manitoba. I was informed by the Department of Agriculture for that province, at the end of May last, that a great deal of harm had been done in the

Stonewall district. From Stonewall to Teulon it was reported that very few farms had escaped entirely, and in many cases the loss was serious. Mr. Arch. Woods, who lives about 2½ miles south of Teulon, had one field of 23 acres of wheat on summer-fallow three-quarters destroyed. The worms were said to clear the crop out completely, leaving the field as black as before it was sown. Mr. C. C. Castle lost 15 acres in the same way, and Mr. Mudd and other farmers in the same locality suffered to a similar extent. The caterpillars were almost full grown on May 19. Unfortunately no specimens of these cutworms were sent to the Division, so the species could not be identified with certainty. The Red-backed Cutworm (*Carneades ochrogaster*, Gn.) was abundant in Manitoba last summer, the caterpillars attacking turnips and many other low plants. The Rev. W. A. Burman reports injuries by this species at Deloraine, and Mr. A. W. Hanham informs me that this was the commonest moth at Winnipeg in the season of 1900. I have never actually detected this species attacking wheat ; but it is a well known pest of Indian corn, and it is quite possible that it may have been the culprit on this occasion.

GRASSHOPPERS IN MANITOBA.

About May 20 reports began to come in on the abundance of various kinds of grasshoppers in Manitoba, and by the end of the month the injuries had assumed serious proportions. An urgent invitation was received from the Provincial Minister of Agriculture for me to visit the districts and advise farmers. Unfortunately previous official engagements rendered this impossible until the end of June, when I proceeded to Winnipeg, and in company with Mr. Hugh McKellar, the Chief Clerk of the Department of Agriculture, visited a portion of the infested district. Through the courtesy of the Canadian Pacific Railway free transportation was provided to any part we wished to visit. Accordingly, leaving Winnipeg on July 2, we proceeded to Stockton on the Glenboro' Branch of the Canadian Pacific Railway, and then drove through the country worst infested round towards Wawanesa, Treesbank and Aweme, where we spent the night, and were hospitably entertained by Mr. Criddle, and where we received much valuable information and saw most interesting specimens of natural history objects. Leaving there the next morning, all too soon, we passed on to Douglas, another point where much harm had been done by locusts. In the afternoon a circuit was made round this place for several miles north-east and south-east. The next day I went on towards Brandon. The places in Manitoba where considerable injury was reported to have been done by locusts were along the line of the Canadian Pacific Railway from McGregor past Melbourne, Carberry, Douglas, Brandon and Oak Lake to Routledge, and south by Pipestone, Lauder, Hartney, and following the Souris river to Glenboro' and thence north-easterly to McGregor. At the time of my visit the grasshoppers were enormously abundant, but all farmers agreed that there was not at that time one where there had been one hundred a few weeks previously. I found every one well acquainted with the habits of the insects and the chief methods of fighting them. The article in my report for 1898, where all the best remedies are given, had been read carefully, but the greatest credit is certainly due to the Provincial Minister of Agriculture and his energetic Chief Clerk, Mr. McKellar, who had spared no effort in distributing information through the press, by holding meetings and circulating leaflets of use to farmers in meeting this outbreak. The farmers had responded promptly and had followed instructions well, by destroying the young insects both by burning them at night when they had collected on rows of straw spread across fields for the purpose, ploughing down stubble fields, the use of hopper-dosers, large numbers of which could be seen in all parts of the country, and by poisoning the insects with a mixture of bran and Paris green. There

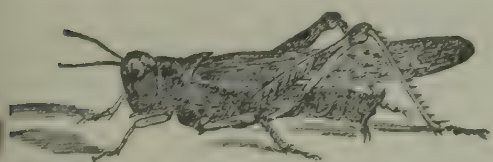

Fig. 5.—The Rocky Mountain Locust.

is no doubt that the efforts put forth at this time had a very appreciable effect upon the numbers of the locusts, and much good was done in reducing the numbers during the hot dry period which prevailed throughout the month of June. The importance of ploughing down all stubble this autumn or next spring was impressed upon farmers by the Provincial Department of Agriculture, so as to complete the work of fighting the grasshoppers which was so well begun last spring. It will be noticed that the area infested this year was not the same as that which was invaded by locusts north of the Turtle Mountains during the two previous summers. A comparative freedom of those localities in southern Manitoba must be attributed, I believe, to the good work done by farmers last year. This serious outbreak was, no doubt, very much aggravated, if not entirely caused, by the dry hot season, which not only checked cultivated crops, but almost entirely prevented the growth of vegetation on the prairies. The only green thing for the grasshoppers to feed upon was the young and half-starved crops on cultivated land. Seeing the hundreds of acres in some places swept bare, I expected to find large swarms of the Rocky Mountain Locust (*Melanoplus spretus*, Uhler), but at only one place was this insect detected, and this was at Douglas. The species which were almost entirely answerable for the destruction of crops in Manitoba in 1900, were the native species *Melanopolus packardii* (Scudd.), *M atlanis* (Riley), and *Camnula pellucida* (Scudd.). These were almost in equal numbers throughout the districts mentioned, and probably the first named was responsible for the larger proportion of the injury, being a large species somewhat like the well known Two-striped Locust, but more active. It is easy to distinguish the species by the broader margin to the thorax and its bright blue tibiæ or shanks. There were many other parts of the West where grasshoppers were more than usually abundant, as is generally the case in dry seasons, but complaints were not made of their attacks on crops.

The following report from Mr. Norman Criddle, of Aweme, Man., gives a concise account of the outbreak at that place, which was one of the centres of worst attack.

'Aweme, Man., December 22.—With regard to the locusts, I forward some extracts from my note-book which may be of use to you. There is no doubt that the poisoned bran was far superior to anything else we tried. It was first used here with success by Mr. Harry Vane of this place.

April 24.—Locusts began hatching.

May 8.—Bulk of locusts are hatched.

May 14.—Several fields cleared off. Still hatching. H. Vane has tried Paris green with some success. Large numbers were ploughed under on edge of fields during night.

May 19.—Found a locust killed by Tachina flies; seven grubs found in ground beneath it.

May 24.—Locusts rapidly eating wheat.

May 25.—Locusts beginning to fly.

May 29.—Seem to have done hatching; are not doing as much damage as formerly. H. Vane has invented a machine somewhat similar to the 'hopper-doser,' only longer. It is made of sheet-iron and burns wood. With this and a mixture of Paris green and bran, the locusts are being kept under control.

May 30.—Hopper-dosers are being used at most places with some success, though not much.

May 31.—We are using Paris green bait with great success; we are spreading it round all the fields.

June 6.—Half the locusts can fly.

June 7.—Still a few locusts hatching. Large increase of Tachina flies in some places.

June 12.—Several people report locusts killed by Tachina flies. H. Vane reports large numbers dead and dying from Tachina flies, two miles west. There are very few here killed by them.

June 20.—Locusts have been flying south-east (with the wind) in large numbers. These were: *M. spretus* and the Lesser Migratory; quite a lot crossed the river.

June 23.—Lots of locusts leaving. They go with every puff of wind.

June 27.—Locusts have nearly all disappeared. A tremendous lot are dead round the field, killed by poisoned bran. They can be picked up by handfuls.

June 28.—Locusts have ceased to do damage. Most of them have disappeared.

August 24.—There has been a slight migration of locusts into this part the last few days. They were of the two migratory kinds, and came from the south-east.

August 30.—There is hardly a locust to be seen.

'The mixture of Paris green mentioned above is made as follows: One part Paris green, one part salt (the locusts will not eat it without), and eleven parts of bran. Mix into a mash, adding as much water as the stuff will hold. Spread in as small lumps as possible. We generally use a trowel or thin piece of iron. Get a little of the mixture on the edge and then fling so that it will spread some 15 yards. A pound of Paris green should make enough mixture to spread a strip two miles long by 15 yards wide. Fresh stuff should be spread every two days. The poison takes from two to five days to kill the locusts, so that they are able to fly long distances before they die. They eat it much more ravenously when they are full-sized than they do when young. Everybody who tried this remedy now swears by it; several of them were heard to say that they will never fear locusts again. I only saw one locust attacked by a hair worm; this was about 11 inches long, and was seen in July.

'No locusts were seen to lay eggs, nor have I been able to find any eggs in the ground. Those that did most damage were Nos. 7, 11 and 13 of those I send; the damage done by them was about even. (They are probably the same, M. *atlanis*, Riley).

'There was also a small percentage of *M. spretus*, which you identified when you were here. I saw several cases of *M. spretus* mating with *M. atlanis* (No. 11). This was noted during the migration south-east on June 20, 21, 22 and 23. During this time they got vastly thicker where before there had been very few.

'The damage done here was greatly over-rated. We lost some 50 acres out of 260, and our fields were the first attacked. Other people lost perhaps a little more which was because they did nothing to stop the advance. The locusts had been increasing here for about three years, in fact, considerable damage was done in the latter part of 1899.'

The grasshoppers certainly were answerable for much loss; but, as compared to the rest of the province, the area where their depredations were of a serious nature was not very large. Many causes added to the loss, which at the time was generally all attributed to grasshoppers. Drought, frost, wind and gophers all did their share of the injury, and as the species most concerned were native species which occur on the prairies in some numbers every year, it is to be hoped that this was merely an exceptional outbreak of local species, which will not recur next season. The probability of this recurrence is certainly rendered less probable by the work which has been done this autumn in following out the wise suggestions as to ploughing, which have been made by the provincial Department of Agriculture.

The two most abundant species throughout the province of Manitoba were *M. atlanis*, the Lesser Migratory Locust, and *Camnula pellucida*, the Pellucid Locust.

These two latter species occurred also in considerable numbers in the Okanagan valley, in British Columbia, where bunch grass pasture lands and grain crops were reported to be seriously affected.

WHITE GRUBS ATTACKING WHEAT.

The White Grub, the larva of the June beetle *(Lachnosterna)*, is a frequent enemy of pastures, and also occurs, as is too well known, in gardens as an enemy of the strawberry, and occasionally in farm lands is a destructive pest in corn fields. This year an attack of some importance on fall wheat was brought to my notice.

'Tancred (Lambton Co.), Ont., October 10.—The White Grub is eating out the fall wheat in this locality, especially on land that is inclined to be sandy. A year ago last spring the June Bugs or Beetles were so bad that my small plum and cherry trees were nearly destroyed by them. I was in a great quandary to know how the young foliage was being destroyed ; not a leaf was allowed to grow until long after other trees were in full leaf. I examined them carefully every day, but not a sign of insect life could I find, until one night I was going to the stable with a lantern, and the thought occurred to me, I'll look at the trees and see if I can find any insect working by night, for I knew the trees, which were two years old, should be exceedingly healthy and thrifty. To say I was surprised at what I found is putting it very mildly. Every twig and limb was one mass of crawling June Beetles. I prophesied a full crop of White Grubs last spring, and sure enough we got them.'—T. H. Myers.

Unfortunately, very little can be done when White Grubs are found attacking a crop. When the beetles attack fruit trees, spraying the foliage with arsenical poisons will destroy large numbers, and when the White Grubs are found destroying the grass on lawns some good may be done by spraying the grass freely with kerosene emulsion and then washing it in with water. The eggs of the June Beetles are laid in spring, and the young grubs hatch soon after, but do not attain their full growth till the middle of the next summer. They then change to pupæ, and soon afterwards into the perfect beetles, which, however, do not emerge until the following spring.

THE PEA WEEVIL OR 'PEA BUG'
(Bruchus pisorum, L.).

Attack.—A small, brownish-gray, very active beetle, one-fifth of an inch long, with two conspicuous black spots on the end of the body, which emerges from seed pease in autumn or in spring, leaving a small round hole. The insect is generally spoken of under the incorrect name of 'pea bug,' and infested pease, as 'buggy' pease. The egg is laid on the outside of the young pod, and the grub on hatching eats its way in and penetrates the nearest pea. Here it remains until full grown, consuming the interior of the pea and passing through all its stages, from a white fleshy grub to the chrysalis, and then to the perfect beetle. Some of the beetles, the percentage varying with the season, escape from the pease in the autumn and pass the winter hidden away under rubbish or about barns and other buildings. The greater number, however, do not leave the pease until the following spring, so that they are frequently sown with the seed.

Fig. 6.—Pea Weevil.

The perfect insects fly easily and resort to the pea fields about the time the blossoms appear. They have been observed feeding upon the leaves and flowers of the pea vines before the pods were formed, but the injury so done is inappreciable compared with the greater loss from the injury to the seeds by the grubs.

The injury by the Pea Weevil during the past season has been very serious indeed, and I wish to impress upon all pea growers in the districts where this insect prevails, the importance, or even necessity, of making a united effort to decrease this great annual loss by adopting some of the well known methods for the destruction of this pest.

The following are extracts from one or two of a great many letters on this subject:—

'Ottawa, November 26.—During the month of August I made a bicycle tour through the counties of Peterborough, Ontario, York and Brant, Waterloo, Wellington, Oxford, Perth, Middlesex, Lambton, Huron, Bruce, Grey and Dufferin. During this trip I paid considerable attention to the insect enemies of farm crops, and discussed the matter with many farmers. From my observations, I do not hesitate in saying that the Pea Weevil is the most important pest with which the farmers in the counties mentioned have to cope. I believe that the losses sustained in the province of Ontario from this enemy are such as should direct more attention to the methods of reducing or even exterminating this insect. In talking with farmers, even where the weevil has been present for a number of years, I found that neither the habits of the insect nor the proper methods of fumigating were very well understood. Farmers who a few years ago grew every year 20 to 30 acres of peas have become so discouraged that 5 or 10 is about the acreage they now grow, and many have dropped peas altogether out of their rotation.'—G. H. Clark.

'Vellore (York Co.), Ont., August 15.—The Pea Weevil is unusually bad this year. A large percentage of the pods have every kernel punctured, and some kernels have two insects in them. Last year, in early-sown field-peas, the bugs matured very early, and at threshing time, shortly after the harvest, they were in swarms in the barn, and the men were covered with them. It was an unusually hot season, with continued drought, which, I presume, hastened the development. Late sowing may result in fewer weevils, but this method is invariably disappointing in the yield and quality of pease. Many people sow one field from year to year, but they always depend upon the early ones for the best quality of pease and straw. A heavy crop of peas has the same beneficial effect upon land as clover, but to a less degree. This result is very apparent on heavy clay lands. The much easier preparation of pea stubble for wheat-growing is of great importance to those who make a specialty of wheat, and as wheat usually does better on pea land than on other stubble, farmers cling to pea growing for the above reason, which, in my opinion, is a very good one. I have told many farmers of the plan of fumigating with bisulphide of carbon; but, when extra trouble and cost as well as some danger are entailed, it seems next to impossible to get farmers to take hold of this; if, however, you could devise some method by which public exhibitions could be given, for instance in properly fitted-up railway cars to be moved from place to place, in which farmers could have their pease treated at a small cost, I think they would soon learn the value of this method, and if it were done for one season, there would be a general clamouring for more of it the second year. A couple of years in any district would so thoroughly demonstrate the benefits as to make it become a recognized duty of every pea-grower to treat his pease, and with this united action much good would result.'—John Lahmer.

'Waterford (Norfolk Co.), Ont., November 7.—There seem to be few Pea Moths here, but the Pea Weevils are very nearly equal in number to the pease.'—N. H. Cowdry.

'Belmont (Middlesex Co.), Ont., December 4.—Pea Weevils have done much harm. If a farmer treats his own seed pease with carbon bisulphide, unfortunately that does not prevent the weevils from his neighbours' fields from injuring his crop. There cannot be much good done unless we can in some way get united action. I am preparing to sow 12 acres of sod with peas next spring, for there is nothing like the pea-vine to thoroughly kill out the grass of a sod field. Before receiving your

letter I had already planned to treat my pease next year. Pease should be threshed as soon as ripe and immediately treated, before the weevil has attained full size or done much damage. If stored away in a barn and threshed in October, the bug has made its full growth and the damage is done.'—H. PETTIT.

There are many valuable suggestions in the above letters, and I am convinced that if pea-growers on a large scale, as well as those who only grow a small quantity for their own use, would regularly fumigate with carbon bisulphide, in a very few years this united effort would have an appreciable effect on the unnecessary loss which occurs every year in this important crop. I believe that most farmers in the districts where the Pea Weevil occurs are pretty well acquainted with the life habits of the insect, and also know that the fumigation treatment is effective. By following the instructions which have been frequently given, and which are repeated here, there is really very little danger ; but of course the work must be done with care. Most of our large seed-growers and seed-dealers do regularly treat their seed, but I think a change for the better might be made by doing this work earlier. Not only is the carbon bisulphide more easily vaporized in hot weather, but its effect on the insects is much more fatal than in cold weather or later in the season, when the weevils are in the torpid state in which they pass the winter. The sooner the fumigation is done after the pease are ripe, naturally, the less the seeds will have been eaten away by the grubs and injured. Moreover, by postponing the fumigation until late in the autumn, in some seasons a large proportion of the weevils will have left the pease and escaped before the operation.

Any farmer can treat his own seed easily and with perfect safety in the following way : Place the quantity of pease to be treated in an ordinary 45 gallon coal-oil barrel, which will hold about five bushels of pease. The quantity of carbon bisulphide which has been found necessary to destroy the weevil is one ounce to every hundred pounds of seed—the treatment to last for 48 hours. Therefore, for the above quantity, as pease weigh from 60 to 65 pounds to the bushel, 3 ounces would be required if the barrel were filled. The chemical may be poured right on to the pease, and the barrel must then be covered quickly and closely, first with a thick cloth or canvas which has been damped in water, and then with boards. The carbon bisulphide will not injure the seed in any way, either as to vitality or as to its wholesomeness as food. Carbon bisulphide is a colourless liquid which readily turns into vapour when exposed to the air, except in very cold weather. This vapour is quite invisible, but has a very strong unpleasant odour. It is heavier than air and therefore sinks quickly to the bottom of and permeates the contents of any closed receptacle in which it is used to free grain of infesting insects. It is, however, extremely inflammable both in the liquid and vapour form ; consequently great care must be taken not to bring any flame, not even a lighted pipe or cigar, near the liquid or barrel during the treatment. The pease or other grain must be left in the tightly closed barrel for 48 hours to destroy the weevils ; it will therefore be best to place the barrel in an outside shed at some distance from the living-house.

The late sowing of pease is certainly useful in preventing attack by Pea Weevil, but the method is not in much favour with farmers, because late sown peas in most seasons are liable to be so badly attacked by mildew as to reduce very much the value of the crop.

Holding over seed.—An easy remedy and an excellent one when only a small quantity of seed is required, is to hold over until the second year after harvesting. This must be done in close bags so as to prevent the escape of the beetle which naturally emerge before the end of the second season, and as they cannot perforate bags even when these are made only of paper, they must die ; for, unlike the Bean Weevil, they cannot propagate in dry grain. The vitality of pease is not injured to any appreciable degree by this delay of one year before sowing. At the time of sowing the seed should be examined and if necessary hand picked ; every grain which has been perforated should be discarded, as it has been proved that it is impossible to grow strong plants from weevilled pease.

The great need in Ontario to-day in this matter is concerted action among all concerned. If a few only treat their pease carefully, little good can be done in controlling this serious enemy, but on the other hand, it cannot be too often stated that, as is often averred by farmers, it certainly is not true that there is no use in one man doing what is right when others close at hand, do nothing. This is a big undertaking ; the Pea Weevil has now for many years been practically increasing year by year, and has now obtained such a foothold that it can only be controlled by stirring up public opinion to the extent of inducing everybody concerned to do something. As a means to this end, Prof. Lochhead, of the Ontario Agricultural College, makes the practical suggestion of bringing the subject prominently forward at the winter meetings of every farmers' institute in the province. This could be very easily done, the life history of the Pea Weevil is perfectly well known and has been published over and over again in official reports, both federal and provincial, as well as in agricultural journals. There is a competent staff of speakers for the farmers' institutes, and it would be almost impossible to hold a meeting in any of the pea-growing counties where there would not be several who could speak on this insect and its work, to the great advantage of many present.

There is, however, every necessity that those who discuss the matter, should prepare themselves beforehand and make it very plain which insect is being discussed. On frequent occasions when reports have been received from correspondents, I have to write to them before I can be sure which insect they mean. The Pea Weevil is the short, roundish, hard beetle which occurs, at the time when it is most often noticed, among seed pease from which it has emerged, leaving a perfectly round hole in the hollowed-out pea, in which it passed its preparatory stages. This insect is shown enlarged, and of the natural size at figure 6. The Pea Moth, as it is generally seen by farmers, is in the form of the caterpillar, usually called the 'worm,' in the pea pods, where the white caterpillars devour the green pease from the outside, leaving a ragged cavity and a mass of excrement. The perfect insect, the moth, Fig. 8, is very rarely seen. It resembles very much the Codling Moth, of the apple, but is of a general slaty gray colour instead of bronzy brown. The Destructive Pea Aphis is a soft-bodied green plant-louse, shown below, very much enlarged. These plant-lice cluster in enormous numbers at the ends of the shoots of peas, of all kinds, clovers and vetches.

THE DESTRUCTIVE PEA APHIS
(Nectarophora destructor, Jnsn.).

Fig. 7.—The Destructive Pea Aphis; winged viviparous female—enlarged. (After Johnson, Md. Agr. Exp. Sta. Bul. 63.)

In my last report considerable space was devoted to the Destructive Pea Aphis, a new pest of the pea, of which no previous attack had been recorded in Canada. The injury extended from all parts of the Maritime Provinces, through Quebec to the western boundaries of Ontario, and the loss in many places was serious. Not only did it occur in Canada, but much greater injury was caused by it in certain of the United States, as Maryland, Delaware, New Jersey, New York, Connecticut, &c. Excellent work has been done upon this insect in Maryland by its describer, Prof. W. G. Johnson, and in Delaware, by Prof. E. Dwight Sanderson, both of whom have published bulletins on the subject.

In Canada during the past season, although the Destructive Pea Aphis has occurred throughout most of the districts visited by it last year, the numbers and injuries have been decidedly less. It has been discovered in the United States that this insect should perhaps be considered more particularly an enemy of clover than of peas. In Canada the species has been found only in small numbers on clover, and no perceptible harm has either been observed or reported to this crop. Wherever the Destructive Pea Aphis was observed, it was attacked to a very noticeable degree by parasitic enemies. All of the species mentioned in my last report were found during the past season in even greater abundance, and in addition to these with every outbreak the fungous disease due to *Empusa aphidis* was more or less prevalent. At Ottawa by far the most inveterate enemy of the plant-lice was the small orange larva of a species of *Diplosis*; these minute maggots, about one-tenth of an inch in length, crawled about on the surface of the pea vines and worked very much in the same way as the larvæ of the *Syrphidae*, or Hover Flies; creeping up to an aphis they transfixed it and held it up, raised from the surface, while they sucked out the juices of its body. The growth of these little creatures was very rapid and there were several broods in the season. When full grown these *Diplosis* larvæ spun a minute cocoon on the stem of the pea plant, or, falling to the ground, spun it there close to the surface, attaching several grains of sand to the outside. This cocoon closely resembles that of the Wheat Midge, or the tiny Cecidomyid *Lasioptera vitis*, of Osten Sacken, which emerges from the Grape Vine Tomato Gall. The winter is passed by the larva inside the cocoon. The plants most seriously attacked in Canada this year were late field peas, sweet peas in gardens and the new crop plant known as the Grass Pea, which is being grown in some districts on account of its exemption from the attacks of the Pea Weevil. Several occurrences of the Destructive Pea Aphis were watched from the time they first appeared this year at Ottawa, on July 27, until the time when permanent snow fell, and a few specimens were found on clover by digging up the plants from under the snow. Parasites of several kinds were abundant throughout the season, and a constant warfare was waged. No sooner did the aphis increase, and appear in large numbers than the parasites appeared in greater numbers and brought them down again suddenly almost to a point of total annihilation. However, at the end of the season a few specimens of the aphis could be found wherever there were chance seedlings of peas and upon late sweet peas, as well as the few mentioned above as found on clover. The attacks of this insect upon the plants where it occurs are of a very pernicious nature, the plants soon becoming stunted, and the flowers, if produced, quickly withering up. Sweet peas which were sown early and had made good growth stopped flowering as soon as the insects appeared, and late sown plants were dwarfed and made no further growth after the attack began.

Last year the worst complaints of injury came from the Maritime Provinces. This year Mr. Robertson, the Superintendent of the Experimental Farm for the Maritime Provinces, writes: 'The Pea Aphis began its work this season in Nova Scotia just about the same time as last year and it looked as if it was going to be just as destructive; but for some unaccountable reason it disappeared all at once, though not until it had completely destroyed peas which were sown late or on poor ground, where they had a sickly growth to begin with. Such as had a strong and vigorous growth were not much hurt. I did not notice any on clover.'

The injury in Ontario is summarised in the following letter from Messrs. the John H. Allan Seed Company :—

'Picton (Prince Edward Co.), Ontario, November 19.—The Pea Aphis appeared in some portions of Ontario last year and more largely in the United States, and has done material damage to the pea crop. This season it has done considerable damage in New York State, Michigan and Wisconsin. Last season, as well as this, it caused injury in Prince Edward county, as well as in Lennox and Addington. We are also told that it did much damage in Renfrew county.'

The losses due to the Destructive Pea Aphis in the Atlantic Coast States have been shown by Prof. Johnson to be enormous, and he quotes from *The Trade,* a canned goods journal, published in Baltimore, the information that the crop of peas of the Atlantic coast this year will not exceed on the outside one-third of what it was even last year, and continues : 'This is about as serious as it can be, when it is taken into account that it is mostly due to this one pest.' . . . 'With this year's experience, however, we have shown conclusively in our experiments and practical work in the field that this insect can be kept in control to a very great extent if taken in hand in time. In the first place, the peas must be planted in rows 24 or 30 inches apart, and not broadcast or in drills, as is frequently the case.' Many remedies were experimented with by Prof. Johnson, and it was found that what he has called the 'brush and cultivator method' was the most effective remedy. For this it is necessary that the peas should be planted in rows as stated above, and when the insects are noticed the vines are brushed backward and forward with a good pine switch, in front of an Iron Age cultivator, drawn by a single horse. In this manner the plant-lice, which leave the vines quickly when these are shaken, were covered up as soon as they fell to the ground, and a large proportion of them destroyed. The operation was not repeated until the third day, as it usually required over 48 hours to destroy the insects when covered with earth. The particulars are given of an extensive experiment, where a 600-acre pea plantation was practically saved by the persistent and energetic efforts of Mr. C. H. Pearson, of Baltimore. All the methods from a practical standpoint were tried on this place, and it was found that the brush and cultivator method was the most effective. Forty men were engaged, and the 600 acres of peas were brushed and cultivated every third day for two weeks, and in this manner the entire field was saved, netting the owner from 25,000 to 30,000 cases of pease, of two dozen tins each. The year before the pease over the same area were broadcasted, so there was no opportunity of fighting the pest, and, as a consequence, 480 acres were entirely ruined. Another method which was tried with considerable success, consisted of a brush which dislodged the insects so that they fell into a pan containing coal oil and water, drawn between the rows of peas. In this way a bushel of plant-lice were caught to each row of peas 125 rods long. Spraying was tested after a thorough trial, upon 100 acres, and all sorts of insecticides for sucking insects were used, but this method of fighting the insect was abandoned, because no spray could be found which would destroy a large enough percentage of the insects to warrant the expense of the operation

THE PEA MOTH
(*Semasia nigricana*, Steph.).

This insect was unusually abundant in the provinces of Ontario and Quebec during the season of 1900. Prof. Lochhead reports it as troublesome this season in the northern counties of Ontario: Grey, Bruce, Huron, Perth, Dufferin and Wellington, but it does not appear to have been quite so destructive as usual in the Maritime Provinces, although inquiries have been received from all three provinces. Some experiments as yet incomplete may be reported upon provisionally, as they appear to be promising. Mr. J. E. Wetmore, of Clifton, King's county, N.B., was good enough, at my request, to try spraying the peas at the time the pods were forming, with the same spray of Paris green and water as is used for the Codling Moth. This experiment was suggested by the similarity of the habits of the Pea Moth and those of the Codling Moth, and although only two sprayings were given, the results were so promising as to show the importance of careful experiments being carried out in spraying peas to prevent loss from the Pea Moth. There should be at least three sprayings, the first applied when the blossoms begin to fall, the second one a week later, and the third ten days later again. As liquids will not adhere easily to such plants as the pea, owing to their waxy covering, it is necessary, after mixing the Paris green and water, 1 pound to 100 gallons, to add whale-oil soap, or some other soap, in the proportion of 1 pound to every 25 gallons of the mixture. Mr. Wetmore's report on the result of two sprayings, is as follows:—

Fig. 8.—Pea Moth: caterpillar and moth. 2 and 4, enlarged.

'Clifton, N.B., October 4.—I think that the injury to pease in this section was less this year than for a long time previously, and, therefore, it was not a very favourable year for the experiment. Early peas never suffer much from the Pea Moth, therefore I did not spray them, and they were not injured by the moth, except a few at the latter end of the pick. I mixed the spray as you directed and applied it with an Electric Sprayer, which only worked tolerably well. The first application was made on July 21, when the blossoms were beginning to fall from the pease, the second one on July 28. I did not spray again, as the pease were about ready for use, and I did not care to have the mixture on them. I gave the vines about the blossoms a good soaking. I picked the first pease for the table on August 1, half sprayed and half unsprayed, and found one caterpillar in each. August 11, tested pease again, but I could not detect any difference in sprayed and unsprayed pease. Very few pods were affected in either, not more than one in fifty. I examined them for moth several times after this, and found the number of affected pods increasing steadily in both sprayed and unsprayed towards the end of the season. There was, however, a noticeable difference between the sprayed and unsprayed at the end of the season, about 9 or 10 per cent of the sprayed pods were affected, while 20 to 25 per cent of the unsprayed were attacked. I also examined pease on my neighbours' plots and found about 25 per cent infested. This result was not entirely satisfactory to me, because the mixture failed to keep the moth off entirely, though the vines were well drenched.

'I do not think, however, that the moth always lays its eggs in the very early stages. I have found a number of very young grubs on pease ready for the table, though the majority were much older. In fact, I found all stages of growth at that period, from very young to big fat grubs.'—J. E. Wetmore.

THE VARIEGATED CUTWORM.

(*Peridroma saucia*, Hbn.)

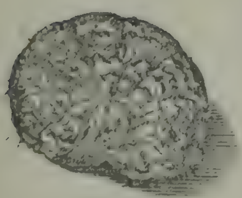

Fig. 9.

Fig. 10.

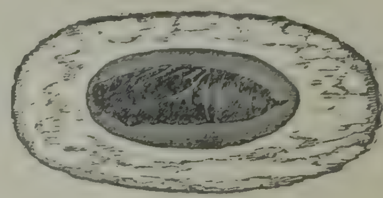

Fig. 11.

Fig. 9. The Variegated Cutworm; Fig. 10, moth; Fig. 11, pupa. (All natural size.)

One of the most remarkable outbreaks of an injurious insect which has ever been recorded in Canada, occurred last summer on the Pacific Coast, extending from Oregon through Washington, and in every part of British Columbia from which reports have been received. The loss in all garden crops was enormous, and was due to the attacks of the caterpillar of one of the noctuid or 'owlet moths (*Peridroma saucia*, Hbn.), which has been named somewhat inappropriately the Variegated Cutworm. The parent moth is known in England under the name of the 'Pearly Underwing.' Not only did this insect occur in disastrous numbers in British Columbia, but it was rather more than usually abundant in Manitoba and Ontario. The first intimation of the outbreak was received from Kelowna in the Okanagan Valley, British Columbia, in a letter dated July 9; but every day after this for more than a month letters were received, accompanied by specimens, all of which proved to be of the same species. The following extracts from correspondence have been selected to show the extent of the injury, and are given at some length on account of the importance of the outbreak :—

'Kelowna, B.C., July 9.—I send you under separate cover in a tin box a half dozen specimens of a worm that is eating our tobacco crop quite seriously. Please tell me what they are and what I must do to destroy them.'—H. G. WATSON.

Mr. Watson was written at once that the caterpillars were the so-called Variegated Cutworm, and the remedies of most use for this class of injurious insects were recommended. Immediately after this began an extensive correspondence with Mr. J. R. Anderson, the Deputy Minister of Agriculture for the Province of British Columbia, who was most untiring in his efforts to distribute information as to the habits of this insect and the best means of meeting its attacks. As soon as any new feature was discovered, which it was thought would be of use to the farmers and gardeners of British Columbia, circulars and emergency bulletins were issued and distributed broadcast. I have no hesitation in saying that the prompt and energetic measures which were carried out by Mr. Anderson in this phenomenal outbreak of such a large and injurious caterpillar, with the habits of which farmers and gardeners were wholly unacquainted, was the means of saving thousands, if not hundreds of thousands, of dollars worth of crops. That the outbreak was of an unusual nature was shown by the receipt on July 20 of the following telegram from Mr. Anderson :—

Victoria, B.C.—Wire advice on receipt my letter seventeenth. Case very urgent.'

The following is the letter referrd to :—

'Victoria, B.C., July 17.—By the present opportunity I am sending you specimens of cutworm, an invasion of which has suddenly set in. They are devastating everything they came across. The first report I received from Lulu Island, where Mr. Tom Wilson found them feeding at night. This was quickly followed by reports from

Cowitchan, Chilliwack, and lastly from Saanich, the outbreak therefore is widespread, and is naturally causing great consternation. You will see that they are of various sizes, but I take it they are all the same species, although quite different in appearance. I have sent a letter to *The Colonist*, giving extracts from your reports as to the remedies for cutworms. Let me have further advice as soon as possible.'—J. R. ANDERSON.

'July 21.—I wired you yesterday asking you to advise me by telegraph as to the subject of my letter of the 17th. Since the 17th I have been deluged with reports of the ravages of these cutworms, and I have published further articles relating to their life history, the remedies, &c., taken chiefly from your reports and from Prof. Slingerland's bulletin. I went out yesterday to Mr. Wrigley's place at South Saanich and witnessed the depredations of these pests. It is truly astonishing to see the manner in which whole fields of carrots and other things are cleared off. Mr. Wrigley was spraying vigorously.'—J. R. A.

'July 30.—Your letter of 23rd inst. received this morning. I am printing part of it in an additional leaflet, giving also extracts from a letter from Mr. Brodie, of the Washington Agricultural Experiment Station. These are going to all the newspapers for publication. The infestation by this insect in Washington amounts to a plague, and I fear most root crops will be lost, as well as other green crops. In consequence of the exhaustion of Paris green in the province and adjoining states, the government was appealed to. I therefore wired you this morning to send 500 pounds.'

'July 31.—I inclose you a copy of an additional leaflet I have published. A meeting of the Victoria Farmer's Institute was held last night at the Royal Oak, for the purpose of considering the cutworm question. I attended it, and read your letter. We all wished you could have been there. The experience of those present went to show that those who used the poisoned bran as you directed were very successful in killing off the cutworm, but the numbers of these are so great that it seems almost hopeless. There was, however, after the meeting, a more hopeful spirit among those present, and I think, if we only had Paris green, every one would use it. The lawns in front of the government buildings here are swarming with cutworms. I have induced the caretaker to have them rolled. This is killing them by thousands.'

'August 2.—I was told by a gentleman from Salt Spring Island that he had noticed five cases of the cutworms devouring those which had been poisoned. I am also told that some of the worms are being attacked by parasites, but I have not seen anything of this myself as yet.'

'August 6.—Paris green came safely to hand yesterday. I am now distributing it to the different Secretaries of Farmers' Institutes.'

'August 15.—I am much obliged for the specimen of *Peridroma saucia* which you have sent. This moth will be very useful to identify our British Columbian specimens by, when they emerge. None of the chrysalids have given the moths yet here, but Mr. Tom Wilson gave me one a day or two ago when I was in Vancouver, which he had hatched out. It is undoubtedly the same insect. Do you think it at all likely that another brood of caterpillars may hatch out before winter?'

'August 16.—I inclose you a copy of a part of a letter from Mrs. J. S. Place, of Dog Creek, B.C., This is a part of the province which I do not think you are acquainted with. I think you will find the letter of great interest, as it gives the date when the eggs were laid. Mrs. Scott. the wife of the mayor of New Westminster, told me that a short time ago she noticed a number of small loopers where the light happened to fall on a light coloured patch on the carpet in her drawing room. She found that they were dropping from a curtain cord where she found the remains of a cluster of eggs. She had previously destroyed several of these egg-clusters which she had found deposited on the curtains and other places in the room.'

The following is the letter Mr. Anderson refers to:—

'Dog Creek, B.C., August 10.—We had an acre and a half of potatoes, and the cutworms ate all the leaves off in two weeks, leaving only the stalks. When they had

finished eating the leaves of the potatoes, they began to cross the fence into the vegetable garden. The fence was just covered with them. However, we cut a ditch through the garden and turned on water. They then tried to cross and were drowned by thousands. Some managed to get over on straws and bits of twigs. We have killed large numbers with Paris green and lime, but we happened to be without any Paris green, and they got a week's start of us. Now I want to ask a few questions. The 28th June was a very hot day, and we had clothes out on the line. When I gathered them in, the clothes had about 50 or 60 separate lots of eggs. I had to get a knife and scrape them off. They were a pale yellow, nearly white. I then went to look at the hops, and found there quite a lot of these egg clusters underneath the leaves. Then we began to look round and found that the same eggs were laid on the windows and all over the verandah. We set to work and got steps and crushed all we could see, which was a very large amount. I thought of sending you some of these leaves, and I am sorry I did not do so. The caterpillars have eaten the potatoes, and now they are thick on the peas and beans. They will eat the end off a pod and then eat the inside. Of onions they eat the top and then go down the stalks. Do you think that the eggs mentioned above are what the cutworms now so troublesome hatch from ?'—MRS. J. S. PLACE.

In reply to this letter, Mr. Anderson answered that he had no doubt that the eggs mentioned were those of the parent of the Variegated Cutworm, and there is no doubt he was accurate in this opinion. Dog Creek is in one of the arid districts of British Columbia, where irrigation is resorted to, and the plan adopted by Mrs. Place in preventing the cutworms from travelling by turning on water is an excellent one which has been resorted to very satisfactorily at Kelowna and Vernon, B.C., during this outbreak.

'Victoria, B.C., September 20.—I have a number of the chrysalids from caterpillars sent to me by Mr. E. A. Carew-Gibson, under date of September 2, from the 150 Mile House, now inclosed in a gauze cage. I will put them out of doors as you suggest, and place some twigs, leaves, &c., for the moths to lay their eggs on when they emerge. Mr. Gibson says in his letter accompanying the caterpillars : "I am sending you by this mail a box containing about 20 pupæ and a handful of larvæ of the year's pest—cutworms. I take it these are the same which are so bad all over the province this year. The amount of damage done and the extent of country covered seems extraordinary. At the mining camp at Horse Fly, an isolated settlement 32 miles from here, cutworms have this year completely destroyed the gardens, and have denuded potato fields of their foliage. They have been equally harmful at Soda Creek and Quesnelle Mouth. We were not able to get hold of the Paris green as quickly as it was needed, and the damage was nearly accomplished before the larvæ were much noticed. These cutworms do not seem at all particular about their diet. The handful I send were picked from under hop vines, nasturtiums and sweet peas, growing against this house." I thought that you would like to get this note of the occurrence at 150 Mile House, because it is so far out of the way.'—J. R. ANDERSON.

'September 21.—Several of the moths from Mr. Gibson's caterpillars have already emerged this morning. This surprised me, as I thought they would be much later.'

To the above quotations from a few of the letters received from Mr. J. R. Anderson, the following extracts from other correspondents, may be added :—

'New Westminster, B.C., July 21.—Cutworms are doing immense damage to all crops on the lower mainland. I have been afraid of this for some time, as I noticed the extraordinary number of common cutworm moths at "sugar". Kindly let me know at once what you advise as the best means of keeping them down. I have found that tobacco sprayed over plants makes them distasteful to the caterpillars. They are everywhere, in fields, in gardens and in greenhouses.'—W. A. DASHWOOD-JONES.

'Vernon, B.C., July 23.—We forward to-day a tin box containing sugar beet and grubs. We first noticed this grub around an old potato pit where we had potatoes

for the pigs last fall. They have destroyed about an acre of sugar beet adjoining this pit. We have them also around the house on the clover, and they have stripped the hops from the verandah. We have a few on our hop-yards, but very few. We trust that they will not increase on the hops, as they are too far advanced to spray with Paris green. We are poisoning with Paris green on our sugar beet, and also surrounding the patch with a ditch and water to try and stop them travelling. Are they likely to be worse next year.'—D. C. RICARDO.

'Comox, B.C., July 23.—I send a number of caterpillars. Please let me know all about them, as they are in such numbers here at present as to be a perfect scourge, and threaten to destroy all vegetation. They attack everything green, field crops, garden crops and house plants. They are here in millions, and are as destructive to the potato as the Colorado Beetle, but are equally so to turnips and other crops. They eat every portion of the leaf except the ribs, which they leave bare and dead. I have been all over the district, and find the pest universal. We are spraying with Paris green.'—JOHN J. R. MILLAR.

'Agassiz, B.C., July 24.—I send five cutworms. These are so plentiful that I picked five on the walk without moving a foot. They are eating the leaves of many of the shrubs, vines, &c., besides garden plants. In the orchard they have attacked the pears. In the field they are eating the fleshy outside covering of the pea pods. The only remedy I can suggest is to sweeten a bran mash and doctor it with Paris green. They are here in swarms. What can we do to protect our crops ?'—THOS. A. SHARPE.

'Froek, B.C., July 25.—I wish you could tell me how to get rid of these worms out of my garden and potato fields. The ground is just covered with them. They eat leaves, stems and everything of vegetables, and then take the root very often. They have destroyed everything for me this year, so that I shall have nothing for winter use. Is there anything I can do to prevent these things next year ? I never saw anything like them before. In the parcel I send, the small ones are picked from the stems and the big ones from the ground.'—NILS FRALANDER.

'Victoria, B.C., July 25.—The enormous numbers of cutworms have naturally reduced the food supply and made it necessary for them to change their usual feeding habits. This necessitates a corresponding change in methods of fighting them. I find them distributed all over all kinds of plants, vegetables, flowers, &c., and feeding at all times of the day and night ; in roots such as carrots and mangels, they eat holes and live inside these ; also in tomatoes ; in fact, they are everywhere. Many complaints are coming in now of their injuring fruit trees and fruit, and the loss to the farming community on their account is going to be very large. In many cases people are slow to use Paris green, being afraid of it, or use it too late. I have had excellent results where the pests are distributed promiscuously over the plants by using a Paris green mixture, dusted or blown through the entire leaf surface, one pound of Paris green to twenty pounds of flour, while the bran and arsenic mixture is effective only in certain instances. A Paris green spray is not so generally effective as the powder form, but I think this is due to the fact that many persons spray too heavily and most of the poison is washed off the plants. Reports are coming in now from Saanich that grain crops are suffering and the work of the cutworms seems almost identical with that of the true Army Worm. It is certainly the most serious occurrence of this nature since I have been in office. I shall be glad to know the proper names of the species as soon as you have reared them. I suppose there will be several different kinds.'—R. M. PALMER.

'Victoria, B.C., August 17.—It is quite a relief to know that you consider it unlikely that we shall have another plague of cutworms next year. Such an event would be indeed disastrous. My own investigations have led me to come to the same conclusions as were stated in your recent letter to Mr. Anderson, namely, that so many of the cutworms are parasitized, at any rate in some localities, that there is no reason to anticipate such a plague in 1901, as we have had this season.'—R. M. PALMER.

'Agassiz, B.C., July 27.—There is what is to me a strange feature in this attack, the cutworms are eating a number of my Thuyas. *Thuya vervaeneana* is one that they appear to be particularly fond of. There appears to be a slacking off in the numbers of these cutworms now, but this may be only temporary. However, many are going into chrysalis just under the suface of the ground. Would it be well to plough clover fields with a shallow furrow and plough or disc with a spading harrow all other fields? Would this have any effect in lessening the caterpillars or killing the chrysalids? I dislike the idea of ploughing up my clover, but would not hesitate if it would be useful. I am told that some hop yards will not pick a hop. Mr. Breed, in Saanich, is one who has no crop this year, on account of the cutworms, and they have begun on the yards here. I saw a field of four acres of potatoes this morning, and I think there is not a hatful of foliage left in the field. Ours, so far, are saved, but how long this will continue I do not know. I sprayed roots, potatoes and trees, until all my poison was gone, and now I would use poisoned bait if I could get the poison, but cannot before Monday or Tuesday.'—Thos. A. Sharpe.

'Maywood, Victoria, B.C., July 28.—I send specimens of a cutworm which is devastating the gardens and fields round Victoria. Whole crops of roots are entirely eaten up, and the corn is now being attacked. It is the most serious disaster I have seen in the eleven years I have lived here. Round five turnips in my garden I found 236 cutworms. Many farmers have lost their entire crops of carrots, potatoes and other roots. A row of sweet peas, sprayed with double-strength Paris green, was again covered 12 hours later. Nothing escapes. Carnations have every flower bud eaten out. Dahlias are eaten to the stems. We shall soon have nothing left. They have attacked the flowers in the conservatories and the tomato houses, where I have poisoned them with bran and Paris green.'—J. W. Webb.

'Victoria, B.C., July 30.—Yesterday I drove out about five miles and saw several gardens. I assure you it was a sorry sight. In some places even rhubarb was entirely stripped, only the stalks and leaf ribs being left. Potatoes were stripped to bare stalks, and the worms were eating the tubers. Some tubers had four or five cutworms in them. These latter are so abundant that they are crawling about in search of food by day.'—Geo. A. Knight.

'Langley Prairie, B.C., July 30.—The worms are destroying potatoes and root crops. Yesterday was the first day I noticed them. They have been very bad at Chilliwack.'—D. H. Nelson.

'Kaslo, B.C., July 31.—We have been suffering all through the Kootenays for several weeks past with a plague of grubs, not the ordinary cutworm, but a dark grub which has attacked all vegetables and almost all flowers. I am now trying whale-oil soap and quassia. The latter I have found the best thing for roses, but from all I can see these remedies will have no effect against this grub.'—Geo. Alexander.

'Armstrong, B.C., August 1.—The cutworms are much larger than our ordinary cutworm, and have been much later in appearing. They are doing an immense amount of damage nearly all over the province, some potato fields being about destroyed. Some people assert that it is the Army Worm.'—Donald Graham.

'Victoria, B.C., August 3.—I have one moth hatched out and many chrysalids, so I hope the worst is over for this season. Still there are many small larvæ yet.'—R. M. Palmer.

'Agassiz, B.C., August 6.—I am sending cutworms of very different sizes. I found them and the chrysalids in the same bed of garden peas. There were so many chrysalids that I was in hopes the trouble was nearly over, but, if the smaller ones have to grow as large as the big ones, it must be some time yet before they pass away.'—Wm. S. Jemmett.

'Agassiz, B.C., August 11.—The cutworm nuisance seems to be abating at last.'—Thos. A. Sharpe.

'Nanaimo, B.C., August 13.—I send you a few notes on *Peridroma saucia*. The moth was very common round my house in June, and I captured several. I do not remember to have taken it in British Columbia before. The first caterpillars I saw were in a field of potatoes at Boat Harbour, on July 15. I did not recognize the caterpillar. It is not one of our common British Columbian cutworms. Since July 15, of course, everybody has heard of it, and the damage done has been very considerable. Mangels, potatoes, turnips, &c., have been bored into, wherever near the surface of the ground. The caterpillars have travelled a little when food was scarce, and they have stripped nettles, thistles and bracken just outside fences. They have also attacked the second growth of clover, and have climbed fruit trees when planted near garden stuff. The larvæ are now pupating, and some moths have already appeared. This, I think, establishes the fact of a double brood. I collected at willows, and presume I should have taken some of the moths, had they hibernated as such.'—Rev. G. W. TAYLOR.

'Nanaimo, B.C., August 25.—*P. saucia* is now coming out of pupa state in considerable numbers. I have no doubt about two broods now, and I fear an attack of caterpillars must be expected in spring.'—G. W. T.

'Kaslo, B.C., August 16.—I made a tour through some ground which I knew had been infested with cutworms, but found that they had all pupated, so I mailed you last night a box of pupæ. These were so thick in the ground that every spade would turn up from three to nine pupæ. These caterpillars when young were blackish-gray on the back and lightish stone colour on the legs and belly, with a row of four yellowish spots on the back. After the last moult the general colour is greenish stone, and the four spots fade considerably, in some specimens they are almost imperceptible. They vary much in colour and size. If I am correct in my supposition of the moth of these pests, it has not appeared here before in any numbers. I had none of the moths prior to last spring. The last visitation of cutworms was in 1892.'—J. W. COCKLE.

'Armstrong, B.C., August 18.—I notice the chrysalids from the cutworms in constantly increasing numbers among my potatoes.'—DONALD GRAHAM.

'Agassiz, B.C., August 18.—The cutworms are gone, but the potatoes, mangels and peas have been seriously injured. In some cases, as the mangels, our crop is destroyed. The peas were lessened 50 per cent, and potatoes are defoliated to a considerable degree, but the absolute injury will not be known until they are harvested.'—THOS. A. SHARPE.

'Chilliwack, B.C., September 3.—Cutworms have been devastating our pea crop and roots. However, I have only lost about 15 acres of peas, so I consider myself lucky; but some of those I have got harvested are shrivelled and very small.'—G. MAXWELL STUART.

'Okanagan Mission, B.C., August 20.—Caterpillars did a great deal of damage here this year, but copious irrigation proved a pretty good method of controlling them.'—J. T. DAVIES.

In summing up the insect injuries of the year in British Columbia, Mr. R. M. Palmer writes, as follows :—

'Amongst insect pests occurring during the year the Variegated Cutworm has made a record of damage far exceeding anything known in the province. You have so much data from Mr. Anderson on this that it is unnecessary for me to deal with the matter at length. The crops which suffered most severely were potatoes, tomatoes, cabbage and allied plants, peas and clover. The cutworm seriously injured the apple crop in some districts, and also defoliated or cut off many young shoots of fruit trees. To prevent the cutworms from climbing the stems of fruit trees, banding them with a strip of the common sticky fly paper proved very effective, and when the Paris green and bran mixture was deposited near the base of the trees, immense numbers of the pests were destroyed. A capital plan in using the poisoned bran for this purpose, is to cover the mixture with pieces of sacking or other material, under which the cut-

worms collect, and feed—while poultry and other birds are prevented from getting the poisoned bran—a very important matter.

'There is no doubt that much of the loss caused by the cutworms could have been prevented by timely use of Paris green, but the plague was so unexpected, much valuable time was lost before farmers generally woke up to what was going on, and when the fight was fairly started, unfortunately the supply of Paris green was not equal to the demand.

'The wide circulation given by Mr. Anderson to your letters containing information as to ways and means of fighting the cutworms was much appreciated, and the methods advised were adopted generally.'

The following epitome of this remarkable occurrence of a common native species was written by Mr. Anderson at the end of the season, and will be read with interest :

'Victoria, December 3.—Regarding the cutworm outbreak which occurred in this province last summer it might appropriately be characterized, on account of its suddenness, extent and the myriads of individuals, as a veritable plague. I have not been able to ascertain how far south and east the plague extended, but it may safely be said that the States of Oregon, Washington and Idaho, and the whole of the province of British Columbia, as far north as any reports were obtainable from, were infested. The first report to this department was made by Mr. Tom Wilson, in the middle of July, he stated that the potato tops on Lulu Island were being devoured by some insect, but which, in spite of diligent search, could not be detected. Suspecting the cause, I advised looking for the culprit at night with lanterns, this was done with the expected result. Not suspecting the infestation to be widespread, I merely recommended the treatment usually followed. However, a few days later reports began pouring in from all parts of the province and bulletins were issued from time to time recommending the remedies you prescribed in your reports. The sweetened bran poisoned with Paris green, when it was used in accordance with directions, was found to be most effectual.

'Unfortunately, the supply of Paris green, not only in this province but in the adjoining states and California, was not equal to the demands, in consequence of which great havoc was wrought before a supply could be received from the East. When at length a supply was obtained, many of the caterpillars had passed into the chrysalis stage. The numbers of the caterpillars were simply incredible ; in places the surface of the ground was described as a moving mass, and where they were poisoned in any numbers the stench was unendurable. On account of their numbers and the consequent scarcity of food, they soon relinquished their natural nocturnal and non-climbing habits, and myriads could be seen crossing the dusty roads in the heat of the day in search of food ; fruit trees, if not protected, were ascended, and the fruit as well as the leaves consumed. Naturally, green succulent food was first consumed, but, as that got scarce, anything and everything was attacked ; after consuming the tops of potatoes, turnips, onions, carrots and such things, the tubers were attacked. Potatoes which were well matured and those which were quite late, escaped with the least loss ; carrots and onions suffered very severely. The potato crop was probably reduced one-third, and other root-crops in proportion. The second crop of clover was almost entirely destroyed. Grain was attacked, but no material loss resulted.

'In August the caterpillars began to enter the chrysalis stage, and their ravages began then to be, of course, much lessened. Altogether, the period of activity lasted about from six weeks to two months. A number of caterpillars which I had in captivity were all in chrysalis by the end of August or the beginning of September. A number of these emerged as moths in October, but I have not been able to discover any eggs. A large number of the moths were also caught in the grass-cutters used on the lawns surrounding the government buildings here. My observations have led me to the following conclusions, viz.: That the cutworms appeared in such abnormal numbers owing to the scarcity or absence of their natural enemies, parasites, birds, &c.; that where fowls were allowed to roam the plague was reduced to a minimum ;

that poisoned bran when used as directed is most efficacious; that parasites are increasing and will probably reduce the numbers of cutworms next season; that from good services rendered in devouring great numbers of these cutworms the crow frequently so destructive to potatoes and other crops in this province, has this year done the farmers good service.'—J. R. ANDERSON.

* Fig. 12.—Variegated Cutworm: moth—twice natural size.

DESCRIPTION OF THE INSECT.

The moth, which is the parent of the Variegated Cutworm, is a large species expanding from an inch and a half to nearly two inches when the wings are spread. It varies very much in colour; the forewings are, as a rule, rather dark brown, but varying to ochreous or russet-brown, shaded on the disk and toward the end of the wing with darker brown; occasionally specimens are quite light along the costal region and at the base of the wing. The wings are crossed by the usual four more or less distinct double wavy bands, but in many specimens these merely show as double spots on the costa. The reniform or kidney-shaped spot is usually darker than the orbicular or round spot, and the reniform bears a few white scales on the outer margin. In two specimens no trace of the reniform or of the orbicular can be seen. The underwings are pearly-white in the centre, with a purplish sheen, bordered broadly and veined with dusky brown, and fringed with white (hence the English name of this moth, The Pearly Underwing). The thorax is of the same colour as the forewings, and bears in the centre a tuft of raised light-tipped scales.

The eggs are laid in elongated flat patches, and were first found by Dr. Riley and figured in his First Missouri Report for 1868. In years of great abundance it is probable that these eggs are laid in various places other than on the food plant. Eggs which were most probably of this species were found upon curtains, on clothes hanging on lines, and on the woodwork of houses, by Mrs. Walton, of Armstrong, B.C., and Mrs. Place, of Dog Creek, B.C. On hatching, the young caterpillars, as is the case with some other cutworms, are loopers, and resemble the larvæ of the Geometrid moths, lacking some of the prolegs which appear in later stages. A full account of the appearance of the larva in the different stages is given by Dr. Lintner in his Fifth Report as State Entomologist of New York.

* Figures Nos. 9 and 11 have been kindly lent by Prof. Otto Lugger, and Nos. 10, 12, 13 and 14 by Prof. M. V. Slingerland.

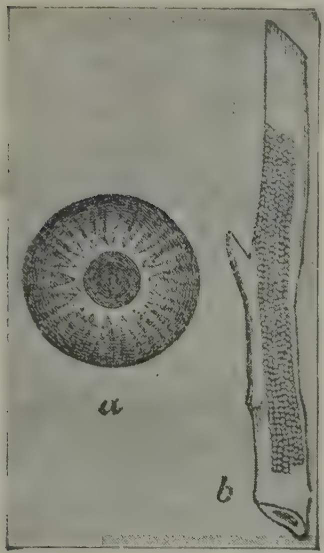

Fig. 13.—Variegated Cutworm : eggs.

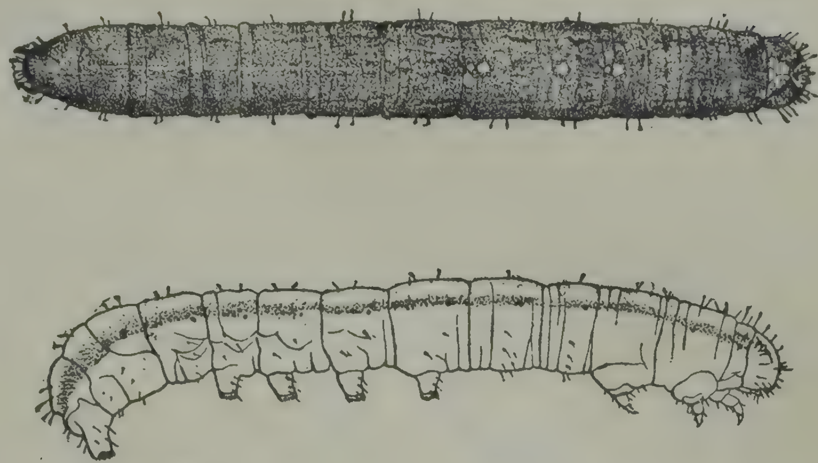

Fig. 14.—Variegated Cutworm—enlarged one-half.

The following is a description of the full-grown larva, the form in which it appeared as such a destructive enemy among the crops of British Columbian farmers and gardeners last season :—

Heavy-bodied cutworms, about two inches in length by over a quarter of an inch in width, of varying shades of gray or stone colour, the whole body finely mottled and variegated with black, gray, brown, or pinkish markings, any one of which may predominate more or less in different specimens ; many have a ruddy appearance from the ground colour of the skin being of a pinkish colour. The markings of these caterpillars consist of a conspicuous yellow band, mottled with orange, beneath the spiracles ; a sub-dorsal interrupted stripe of velvety black blotches washed with orange, sometimes very conspicuous, but at others almost obliterated ; a medio-dorsal line of yellow, almost continuous from the head to the apex of the anal flap. This line expands into four or sometimes five conspicuous yellow spots, situated in the centre of the middle segments. These spots are always present on segments 4 to 7, those on 5 and 6 being the largest. There is also occasionally a spot on segment 3. The supra-stigmatal area bears on each segment, except the head, a diagonal blackish, curved, almost S-shaped mark, the lower end of each of which incloses the black spiracle. These marks form a wide, but on some specimens distinct, sinuous band between the sub-dorsal stripe and sub-stigmatal band. On segment 12, the sub-dorsal stripes meet and form a black velvety patch, somewhat like the letter W, with the lower part filled in. Behind this, on segment 13, and the posterior third of segment 12, is an orange or pale patch, sharply defined anteriorly against the straight edge of the velvety patch on segment 12. The ventral surface is paler than the dorsal and glaucescent. Head round, deeply cleft at summit, testaceous, coarsely mottled with brown or reddish markings. In the centre of the face are two curved black stripes which, starting from the summit of each lobe of the head and converging, meet above the frontal triangle, and then run down to the base of the antennæ. Thoracic feet testaceous ; prolegs concolorous, bearing testaceous chitinous plates at the base exteriorly ; claws blackish.

When full-grown, these caterpillars burrow a short distance into the ground and form a smooth oval cell, in which they change into the chrysalis or pupal stage, when they are of a bright chestnut brown, about three-quarters of an inch in length. The anterior segments following the rounded head parts and to the tips of the wing covers, are cylindrical, but the six remaining segments, as has been noticed by several correspondents, are capable of movement. These segments diminish in size to the tip, which is armed with two slender black spines, which lie so close together as to appear as one, unless closely examined with a magnifying glass. This stage for the second brood, of which the moths emerged in August and September, was from 20 to 23 days.

There is no doubt that there are two broods of this moth in Canada, as was stated to be the case by Dr. Riley, in Missouri, many years ago. The moths of these two broods appear normally about the end of June and after the middle of August; but it seems as if some individuals of this latter brood may be delayed in emergence till late autumn, or even till the following spring. Prof. Otto Lugger writes that he has taken this moth so frequently at St. Anthony Park, Minn., very early in the spring, from March 2 to 27, that he feels almost certain that at least some of the moths may hibernate as such. He has also found them very late in autumn, after all foliage had disappeared from plants. In fact, he finds such irregularity in the appearance of this species, that they can be obtained almost throughout the season. On November 9 last, I dug up at Ottawa two pupæ which produced the moth ten days afterwards indoors. This was nine days later than the date when the ground was covered with a fall of snow, which has remained ever since, and will in all probability be here until next spring. Therefore, had these pupæ not been found, the moths could not have emerged from them until next year, showing that the species sometimes hibernates as a pupa; but a large number of the moths, by far the largest of those reared this year, appeared by the third week in August, and it seems probable that with this species, as with a great many other cutworms, egg-laying would take place by the end of August and the beginning of September, that the young larvæ would hatch and make part of their growth before winter, or even, as in the case of *Carneades ochrogaster*, Gn., that the eggs might remain unhatched until the following spring; it would thus appear, from the very diverse dates at which the perfect moths and caterpillars have been found, that this species may pass the winter in almost any stage, and this is doubtless the case with a great many other species, the life histories of which have not been perfectly worked out. An excellent article on the Variegated Cutworm has been published by Prof. Slingerland (Bull. 104, Cornell Agric. Exp. Stn., 1895.)

The most important facts with regard to the insect are the class of crops which are likely to be injured by it, and the best remedies with which to prevent its injuries. As to the range of its food plants, the extracts given above indicate pretty well that almost any vegetation is acceptable.

Professor French, in the Seventh Report of the State Entomologist of Illinois, says: 'The Variegated Cutworm is widely distributed, and it is probable that we have no other species that is more voracious or is a more general feeder. While some kinds of cutworms are not found much out of certain situations, this may be sought in any place during its season with a good prospect of finding it. There seems to be no cultivated crop that is free from its attacks, and when these are not at hand, it readily preys upon weeds that are found in fields and by the roadsides.'

Remedies.—The remedies for cutworms have been given so frequently in former reports that it is hardly necessary to repeat them in full here. Briefly, they consist of:

(1). The banding of freshly set-out annual plants with rings of paper or tin.

(2). The poisoning of the caterpillars either with traps of fresh vegetation tied in bundles and, after being dipped is a mixture of Paris green and water, or other poison, distributed at short intervals over infested land, when the cutworms appear. A modification of this remedy which has given the greatest satisfaction in British Columbia during the past season, is known as the poisoned bran remedy. This was first used successfully on a large scale some years ago in California as a remedy against grasshoppers in vineyards, since which time it has come more and more into use, owing to its efficacy and the ease with which it can be prepared and applied. This mixture consists merely of bran, moistened with sweetened water, and Paris green, mixed in the proportion of 1 pound to 50 pounds of bran. In making this mixture, the most convenient method is to dampen a small quantity with the sweetened water, a few ounces of sugar in a pail of water, and then add more dry bran until the whole is almost dry again. If the Paris green is added to the bran without

dampening it, it sinks with remarkable rapidity to the bottom, even in this dry mixture, when it is stirred. If it is desired to use the poison as a wet application, more water can be added until it is of about the same consistency as porridge; but if to be used dry, dry bran must be stirred in until the mixture will run through the fingers easily. This poison may then be applied to the land, either around or between plants to be protected, or a row of it may be run close to the drills of crops planted in that manner.

PARASITES.

The valuable aid rendered by parasites, whenever any injurious insect appears in unusual numbers, is so well known that the practical entomologist is always on the alert to detect if these are present during an outbreak of an injurious species, such as occurred in the case of the Variegated Cutworm in British Columbia during the summer of 1900. That these were present in some numbers was proved, but they seem to have been local in their distribution. They are, however, difficult to detect, and it is to be hoped that they may have been overlooked in many instances. At Nanaimo they were looked for carefully but unsuccessfully by the Rev. G. W. Taylor, an experienced entomologist, and he is of the opinion that there may be trouble again in that locality next year. The experience of the past with regard to similar outbreaks would, however, seem to justify a more hopeful view of the case. Cutworms of all kinds have many enemies, both parasitic and predaceous, and these increase with remarkable rapidity, so that two successive years marked by such an outbreak as was experienced this year would be almost without precedent. Not only will parasitic and predaceous insect enemies, and fungous and bacterial diseases have increased, owing to the large food supply, but many insectivorous birds and domestic animals, having learned how to find them, will be ready to assail them next year on their first appearance. The phenomenal abundance of the Cutworms and the wide-spread injury they wrought has forced farmers and gardeners to learn their habits and acquaint themselves with the most practical remedies. The following are a few extracts from correspondence bearing on the subject of the natural enemies of the Variegated Cutworm in British Columbia.

'Nanaimo, August 13.—I have boxed up a couple of hundred caterpillars of *saucia* for the sake of breeding parasites; but they seem remarkably healthy, and I have not seen a single one attacked by Tachina Flies.'—Rev. G. W. Taylor.

'Victoria, August 17.—I send larvæ of what I take to be a parasite. The man who brought them to me said he put cutworms only into a jar, and on looking at them a few days ago, he found one dead one, killed, I think, by parasites, two chrysalids and these larvæ in an earthen hollow which had, I think, been inhabited by the host.' —J. R. Anderson.

'Victoria, August 3.—You will be pleased to learn that some of the caterpillars are parasitized by ichneumon flies, and it is reported to me from Salt Spring Island that "white eggs" (Tachina eggs ?) are on many of the cutworms near their heads.'— R. M. Palmer.

'Victoria, August 17.—Three lots of larvæ which I had under observation, were almost all destroyed by the maggots of a parasitic fly, no doubt the same species as you found in your Victoria consignment of larvæ. Field investigations show the parasites to be well distributed.'—R. M. Palmer.

'Vancouver, August 20.—I saw in a recent letter in the papers (with reference to cutworms) that you state that cutworms turn to moths. In going over a farm near here, I picked up a number of chrysalids, among others one that was just bursting, in fact the insect was partly out; it was not, however, a moth, but a large black fly, and seemed to pretty well fill the chrysalis. The fly was not unlike a black flying ant, but with very long legs, in fact a sort of cross between a flying ant and a hornet. It had a small sting apparently. Is this a parasite of the cutworm ? I have frequently

seen these flies in the gardens and on the farms. There are a great many about just now.'—C. E. HOPE.

This last important observation evidently refers to an Ichneumonid parasite. The larvæ sent by Mr. Anderson produced *Meteorus vulgaris*, Cress., a well-known parasite of all kinds of cutworms, and the flies mentioned by Mr. Palmer, as reared at Ottawa, from caterpillars sent from British Columbia, were the large muscid the Cattle Fly (*Muscina stabulans*, Fallen), of which no less than 17 were reared from one sending of caterpillars from Victoria.

'Nanaimo, August 27.—*P. saucia* is now coming out of the pupa state in considerable numbers. So far as I can see in this district, the parasites have not done very much for us. I have only seen one caterpillar attacked by hymenopterous parasites, and only a very few by diptera. Many caterpillars, however, have shrivelled up in the pupal cell without changing.'—REV. G. W. TAYLOR.

Several correspondents mentioned finding the caterpillars dead on the ground, or in the cavity made in the ground by the cutworms, before turning to pupæ (or chrysalids). Some of these were sent by Rev. G. W. Taylor, who had found them in considerable numbers at Nanaimo. These were forwarded to Dr. Roland Thaxter, at Harvard University, in the hope that a parasitic fungous disease might have been discovered, but unfortunately no fungus could be detected. Dr. Thaxter writes: "I looked at the *saucia* larvæ soon after receipt, but found no sign of fungus. It is possible that it may have been bacteriosis, but it would be impossible to determine this from the material. Such cutworms are subject to *Empusa aulicae*, and I have no doubt that if careful investigation were made during one of these invasions, this or some other *Empusa* would be found destroying them.'

PREDACEOUS ENEMIES.

Wild birds were occasionally spoken of as destroying these caterpillars, but as a rule the kinds were not specified. Robins are mentioned by Mr. Dashwood-Jones, and the following letter is from Mr. J. R. Anderson :—

'Victoria, August 15.—'I am sure you will be pleased to hear a good word spoken in favour of the execrated old Crow. For some time before it was discovered that the cutworm plague was upon us, I noticed first one, then several, and then a large number of crows busily engaged among the grass on the lawns in front of the Government buildings. On investigation I discovered that they were after the cutworms, and good work they must have done judging from the assiduity with which they pursued their labours. I have since had similar reports from several parts of the province, and even the still more execrated Blue Jay has come in for a good word from some quarters. The old adage is borne out that a certain gentleman is not always as black as he is painted.'

Chickens and ducks are mentioned by several observers as having done good work. The following are among the most interesting records :—

'Victoria, July 30.—I saw a remarkable thing yesterday. There were two gardens close together with the same kind of soil, &c. One was beautiful, the other was eaten bare by cutworms. Chickens had the free run of the first, in the other there had been no chickens. In small gardens there would have been very little trouble in keeping them clean.'—G. A. KNIGHT.

'Victoria, July 28.—I turned the chickens into the garden, giving them water, but no wheat, and they are working at the caterpillars all day, but cannot get rid of them all ; they are in thousands, every handful of soil is full of them. Ducks seem to eat even more than the chickens, but want some one with a rake to bring the worms to the surface.'—J. W. WEBB.

Pigs were very useful at Agassiz.

'August 6.—I intended to put down some poisoned bran, but I found nine of my young pigs in the potato field, travelling regularly up the furrows, just moving

the earth sufficiently to get at the worms. In no case did I find the potatoes uncovered or touched; from the look of it, the pigs must have been at this work for some days. They are about 5 or 6 weeks' old, and seem to have lived mostly on these worms. They have eaten nothing in the sty, except from the mother, until the last 2 or 3 days, and they are perfectly fat. I knew they ate a lot of raspberries, but could not see how they got so fat on them. The potato field joins the pig field, and it is my intention to turn the pigs in as soon as I have lifted the potatoes.'—WILLIAM S. JEMMETT.

As there is a possibility that the Variegated Cutworm may again appear in British Columbia next season, it will be wise for every one to be keenly on the lookout for its first appearance in any form, and to write and send specimens promptly to the provincial Department of Agriculture in Victoria, or to this Division, so that advice may be given as to the best steps to take under the circumstances to prevent loss. Observations on the occurrence of parasites, and predaceous insects, and of work done by wild birds, poultry, pigs, &c., will be of special interest, and I shall be greatly indebted to any observers who will report to me any instances which may come under their notice.

THE SPOTTED CUTWORM

(*Noctua c-nigrum*, Linn.).

Among the outbreaks of cutworms reported to this Division during the season of 1900, mention may be made of one which occurred in Ontario just at the same time that the Variegated Cutworm was doing so much damage on the Pacific coast. Injury was reported from Niagara and several places north of Lake Ontario. The moth was also extremely abundant at Ottawa from July to the end of the summer. Almost all kinds of vegetation, with the exception of the various grasses, were attacked, and the larval habits of this species seem to resemble very closely those of the Variegated Cutworm. Young larvæ in the looper stage were received from Niagara, from Mr. Joseph Healey, on June 13, who had found the cluster of eggs upon an apple tree and the larvæ were reared to maturity upon the leaves of that tree. Pupation continued from July 24 to 27, and the moths all appeared from August 18 to August 25. The following extracts refer to two of the worst occurrences reported :

'Whitby, July 25.—Upon examining some tomatoes to-day, the fruit of which is not more than half grown, I discovered that, with scarcely an exception, the tomatoes were more or less eaten by greenish coloured grubs, the largest of which were a little over an inch long, some being quite small. They ate through the skin and then consumed the inside. There were a number, a dozen or so, in each tomato. The plants are healthy and vigorous, the foliage not being affected. There are thirty or forty plants in the patch. Every one I examined was in the same condition. The grubs are not very active. As the matter may be of economical importance, I thought it would be well to let you know about it at once. It may, of course, be only a casual invasion; but, should it spread and become general to the extent that this patch of mine is affected, it will prove a serious matter for tomato growers.

'Since writing the above I have learned from my man that there were a large number of these same grubs in a patch of oats and peas growing alongside of the tomatoes, and that on a nearby farm there were immense numbers in a field of peas. Some cauliflowers growing near my tomato plants are also being visited.'—W. O. EASTWOOD.

'July 30.—As requested I send you some of the grubs from my tomatoes. My man tells me that, upon pulling up some of the affected plants, he found bunches of the grubs an inch or more below the surface, also that they are thick in a field of peas about half a mile from here.'—W. O. E.

'Pefferlaw (York Co.), Ont., July 30.—I send you by mail a box of worms which are abundant on the farm of Mr. James Cornwall, of Georgina township. They have

stripped a field of carrots and mangels. They devour the leaves of Canada Thistle, gooseberries, choke-cherries, &c. A field of oats beside the carrots is untouched. About eighty rods away, on the farm of Mr. W. Jackson, they have devoured a field of peas. After eating the leaves of the mangels they attacked the roots and ate large holes in them. They can be dug out of the ground around the carrots and mangels in large numbers. Kindly tell me what they are and advise a remedy.'—THOMAS CORNER.

Like the Variegated Cutworm this is a double-brooded species and is never a rare insect ; but this year it was exceptionally abundant. It was the second brood, the larvæ of which are found in July, which was so destructive this year.

The following is a description of the full-grown larva of *Noctua c-nigrum*, the Spotted Cutworm.

Length, about one and three-quarters inches, by slightly less than a quarter of an inch in width. The markings of this caterpillar are in a general way very similar to those of *Peridroma saucia*, except that the mottlings are finer and less distinct, thus by contrast making the bands and stripes more prominent. The medio-dorsal line is continuous and not expanded into the yellow spots so characteristic of the Variegated Cutworm. The black velvety blotches of the sub-dorsal stripe are more clearly defined, and the posterior extremities do not meet on segment 12 in the black W-shaped blotch of *P. saucia.* The black blotches of this line are all separate and decrease in size anteriorly, and each one bears in front of it, lying towards the centre of the dorsum, a pale blotch, behind which in the centre of each segment is a smoky shield-shaped blotch. These markings give a much more checkered appearance to this caterpillar than is the case with the Variegated Cutworm. The sinuous band between the infra-stigmatal band and sub-dorsal stripe is also shadowed above with pale blotches. The ventral surface is conspicuously paler than the dorsal. This caterpillar as compared with the Variegated Cutworm is more slender, shorter, and the colour is, as a rule, ruddier, the mottlings much finer and the black marking more contrasted with the ground colour.

These caterpillars when full-grown burrow into the ground and form a cell in the same way as the Variegated Cutworm. The length of time from the hatching of the eggs until the caterpillar is full-grown is about six weeks in summer. The hibernating larvæ begin feeding in April and produce moths by the end of May or early in June. It has been noticed, however, by Dr. Forbes, in Illinois (Ill. Agr. Exp. Stn. Bull. 60) that a few are said to continue much longer in the pupal stage, even as late as August. This retardation of development is a common feature with many insects, of all orders, and is doubtless a provision of nature as a means towards the preservation of species.

The moth of the Spotted Cutworm, which, from the markings on the forewings, has been called the Black C Rustic, is a rather showy moth of about an inch and a half in expanse of wings. The forewings are, as a rule, purplish brown, sometimes almost black, in the females, and much paler in the males. There is a black C-like spot in the middle of the forewing, the open part towards the front edge of the wing, and filled with a much paler blotch, which extends beyond the C-like spot and merges with the general colour of the wing. There is great variation, however, in the shade and intensity of the colouring, specimens of both sexes being lighter or darker than the average. The hindwings are dusky, paler towards the base, and of a satiny lustre. The thorax is of the same colour as the forewings, with a distinct pale collar.

The remedies which are recommended for the Variegated Cutworm on a previous page will be found applicable to this species also.

There were but few parasites noticed among the caterpillars sent with the above letters, but upon one larva three curious egg-like bodies were observed, which proved to be the larvæ of a small hymenopterous parasite, which has been identified by Mr. W. H. Ashmead, of Washington, as *Euplectrus frontalis*, How. These parasitic larvæ were oval, like minute white eggs, at first, but later were attenuated posteriorly and about one-twelfth of an inch in length. They were attached to the back of the cater-

pillar, close to the head, and only relaxed their hold when full-grown, to spin their light silky cocoons among the leaves close to the dead body of the caterpillar, which they had destroyed.

THE CABBAGE PLUSIA

(Plusia brassicae, Riley).

Fig. 15.—The Cabbage Plusia: *a*, caterpillar; *b*, cocoon; *c*, moth.
(Cut kindly lent by Dr. S. H. Forbes.)

This insect is frequently a serious enemy to the market gardener in the United States; but I have never received a complaint concerning its work in Canada until the present year. This has been a matter of some surprise to me, because it has been the cause of much loss in States of the Union close to our boundaries, both in the East and in Minnesota. In July last, specimens of the caterpillars were sent in from the North-west, and moths were taken at Ottawa and St. John, N.B., for the first time.

'Regina, Assa., July 18.—The caterpillars I send have been doing some damage in gardens here. I observed them first on potatoes about three weeks ago; they ate small round holes in the leaves. They have since turned their attention to lettuce. In my own garden they ate a row of green lettuce right to the ground before I found out what was the matter. They have since got into the bronze variety; but do not appear to devour it so voraciously as the other. I have found them in a neighbour's garden eating the leaves of celery much in the way they attack potatoes. The colour of the caterpillar is a bright, rather blue, shade of pea-green, somewhat whitish along the back. It is very lively, especially when small, and when disturbed rolls itself into a ball. Some of the caterpillars are now spinning their cocoons in the lettuce leaves. Please let me know what species it is, and what remedy to apply.'—J. R. C. HONEYMAN.

The Cabbage Plusia, also known as the Cabbage Moth, and, in the caterpillar form, as the Cabbage Looper, is said to be, where it occurs, the worst pest known on lettuces grown in forcing houses. It would appear as though this insect were becoming year by year a worse pest, and that the area where it occurs as an injurious insect is enlarging. It may be that before long we may, in Canada, have to reckon with this insect as a regularly recurring enemy.

The most practical means of preventing the work of the caterpillars on lettuces in forcing houses is stated to be the keeping of the ventilators closed with mosquito netting. It is thought that the eggs are sometimes laid on plants before they are taken into the houses, but probably the moths gain access to forcing houses more generally through the ventilators. There are many other plants in greenhouses which are attacked by this caterpillar. In the autumn they have been found troublesome among chrysanthemums, cutting off the flower buds. Smilax and other plants have also been injured. In the open ground the caterpillars are most destructive to cabbages and related plants, such as have smooth leaf surface. They feed on the surface of the

leaves, and are said by Mr. Sirrine to be much more particular about what they eat than is the case with the imported Cabbage Worm. They walk rapidly, and, if they find any foreign substance on the leaves, they move off to other parts of the plant.

The caterpillars are pale green, striped with longitudinal whitish lines. The body of these caterpillars is shaped differently from most of the common noctuid caterpillars found in gardens, in that it increases gradually from the head to the last segment, where it is largest and slopes off abruptly. Another noticeable difference between the caterpillars of the Plusias and other noctuid caterpillars, is the fact that they have only two pairs of prolegs instead of four. There are several species of these insects, but none have ever proved very troublesome in Canada. In 1884, the Cabbage Plusia was very destructive in the State of Minnesota, almost equalling the injuries of the common Cabbage Worm *(Pieris rapae,* L.). Dr. Forbes states (Ill. Agr. Exp. Stn. Bull. 60) that the larva feeds on celery, kale, turnip, tomato, lettuce, mignonette, dandelion, dock, clover, lamb's quarters, and some less common cultivated crops. It ranges through the United States and occurs also in Canada. The eggs are laid upon the food plants, singly or in small clusters The larva spins a gauzy cocoon among the leaves. The pupa is light yellowish brown in colour. The moths are very dark, the upper wings being almost black or very dark gray, marked with small white points and indistinct bands, and having a silvery U-shaped spot on the middle of the forewing, and a smaller round silvery dot close to it on the outside. There seem to be two broods of this insect in Canada.

It has proved to be a difficult matter to destroy the caterpillars of the Cabbage Plusia upon cabbage and lettuce crops. Mr. F. A. Stirrine (N.Y. Agr. Exp. Stn., Bull. 144) tried many experiments with remedies, and found that a soap wash containing arsenical poisons proved the most useful. He speaks of this as a resin-lime mixture and gives the best formula for its preparation. The estimated cost for preparing and applying this remedy is $2 an acre.

THE SAN JOSE SCALE

(*Aspidiotus perniciosus*, Comsk.).

This insect continues to receive the keenest attention from practical entomologists in all parts of North America, and most careful experiments have been carried out in the endeavour to find any treatment which will control the scale without injuring the tree. At the present time crude petroleum and whale-oil soaps (caustic potash fish-oil soaps) seem to give the greatest promise in this direction. With regard to crude petroleum, more experience seems to be necessary before a definite recommendation can be made as to the strength and manner in which it can be safely applied. Mr. George E. Fisher, the chief Inspector for San José Scale for the province of Ontario, has experimented extensively during the past summer with both of the above-mentioned materials, and the results of this work, which he presented in an important address before the Entomological Society of Ontario, at the annual meeting in November last, may be summarized as follows :—

Fig. 16.—San José Scale; apple branch with scales; large scales above at left.

Whale-oil soap, at a strength of two pounds to one gallon of warm water, killed many scales; but in no case was complete success obtained, however carefully the work might have been done. The trees, nevertheless, were in most cases benefited by the application. The scale was reduced to the

greatest degree on cherry trees, and aphids were quite destroyed. Even when trees were in blossom, no injury from the soap was noticed. The treating of trees with the whale-oil soap did not prevent the young scales from settling soon afterwards on the parts treated.

Crude petroleum gave better results as far as the scale was concerned. A mechanical mixture of water with 30 per cent crude petroleum could be used quite safely on apple trees, and also with care upon plum and peach trees ; even this, however, was not a perfect remedy, as all the trees treated had some scale upon them at the end of the season. Mr. Fisher considered that a combination of whale-oil soap and crude petroleum would probably be found the best remedy. He did not think it safe to recommend crude petroleum for general use. The ordinary fruit grower would not use even the whale-oil soap in accordance with instructions, and he felt sure they would use crude petroleum in the same careless way, and trees would be killed. He believes that a frequent cause of injury from crude petroleum when applied with water is that operators when spraying, go over trunks and other parts of trees twice ; beginning on the trunk, they go over the tree and finish up again on the trunk, thus depositing two applications or twice the necessary quantity of oil, because the water evaporates quickly but leaves the oil on the tree. Imperfect work is frequently done from the difficulty of reaching the upper side of the high branches on the opposite side of a tree which is being sprayed. The best time to apply the spray, whether of soap or of crude oil, is in April.

A word of warning may be here inserted for the benefit of those who may wish to use crude petroleum with regard to the variation in the specific gravity of crude petroleum from different wells. Dr. J. B. Smith, who has certainly done more to test the value of this remedy than anyone else, says (New Jersey Bulletin, 146), after giving the specific gravity of several samples :—

'Thus thirteen samples register 50° or over, leaving 70 that run between 40° and 49°, the majority running nearer to 46° than to 44°, both in green and in amber oils. It is a fair requirement, then, for a straight crude petroleum that it should have a specific gravity of 43° or over, at a temperature of 60° Fahr.; anything less might be harmful; anything more than 45° is unnecessary.

The importance is thus shown of knowing what the specific gravity by the Baumé oil scale is before any sample is used by a fruit-grower upon his trees.

The San José Scale exists in Canada only over a small area of the province of Ontario, extending from Niagara around the western end of Lake Ontario as far as Burlington and westward through the counties bordering on Lake Erie, and, even in that area, although it is true that the scale has increased considerably during 1900, the outside limits of this area have not been extended, and it is only in certain orchards where the insect occurs. In addition to this the majority of the owners of these orchards understand now the danger of neglecting to treat their trees, and are adopting vigorous measures to control the pest. The area may be described in general terms as that part of Ontario where the peach can be grown commercially. All reports of the occurrence of the San José Scale in other provinces are erroneous. The only other province where it has ever been found living on trees, is British Columbia ; this was some years ago, and Mr. R. M. Palmer, the official Inspector of Fruit Pests, expressly writes on this subject :—

'Victoria, B.C., November 21.—You will be glad to know that there is no San José Scale in the province. Reports of the presence of this dreaded pest from Salt Spring Island and Cowichan district, upon investigation, proved to be unfounded. The "scare" arose from the fact that many apples affected with the "leaf-spot-fungi" developed a red-spotted appearance somewhat like the discoloration of the fruit caused by San José Scale.'—R. M. PALMER.

An important step with regard to this insect was taken by the Hon. Minister of Agriculture last spring in putting through an amendment to the San José Scale Act, by which under certain restrictions nursery stock was allowed to be imported

into Canada from countries where the San José Scale was known to occur. When it was discovered that this insect could be killed on nursery stock by fumigating with hydrocyanic acid gas, at the urgent request of many fruit-growers, horticultural societies, nurserymen and others, by instruction of the Minister of Agriculture, proper fumigating houses were erected last spring at such points on the boundary as it was thought would be most convenient to importers, and qualified superintendents were appointed to treat any nursery stock, trees, shrubs or other plants as might be imported through these ports, and then repack and send them on to their destination as promptly as possible. For this fumigation with hydrocyanic acid gas the formula recommended by the United States Entomologist for dormant stock was adopted, it being the simplest effective formula, viz.: one fluid ounce of commercial sulphuric acid, one ounce of refined cyanide of potassium (98 per cent), and three fluid ounces of water to every 100 feet of cubic space—exposure 45 minutes. These fumigating houses were located at the customs ports of St. John, New Brunswick; St. John's, Quebec; Niagara Falls and Windsor, Ontario; Winnipeg, Manitoba; and Vancouver, British Columbia. The whole expense of these stations was assumed by the Dominion Government, but all shipments were made entirely at the risk of the shippers or consignees, the government assuming no risk whatever. The packages had to be addressed so as to enter Canada at one of the above named ports of entry, and the route by which they were to be shipped, clearly stated upon each package.

Many horticulturists and nurserymen availed themselves largely of this concession, and at every port much stock was imported from the United States and Japan. Nursery stock of all kinds can be imported from Europe without fumigation, as the San José Scale has never gained a foothold in European countries. Certain other plants which are not liable to the attack of the San José Scale are also exempted from treatment under the San José Scale Act. These are: (1.) green-house plants, including roses in leaf which have been propagated under glass; (2.) herbaceous perennials, including strawberry plants; (3.) herbaceous bedding plants; (4.) all conifers; (5.) bulbs and tubers.

The fumigating houses were kept open with a superintendent constantly in attendance throughout the seasons of spring and autumn shipments of stock. Owing to the lateness of the season at which it was decided to do this work, the fumigating station for British Columbia was not operated until the autumn season of 1900, and, as all vegetation is much earlier in Oregon and Washington States, from which most shipments are made into British Columbia, it has been arranged that for that province the fumigating house shall be kept open for the winter months from October 15 till March 15. For Manitoba and the Eastern Provinces the spring season is from March 15 till May 15, and the autumn season from October 7 till December 7.

The San José Scale, although only occurring as stated above in a comparatively restricted area in the province of Ontario, has increased considerably in orchards which were infested last spring and other orchards adjacent to them. Nevertheless, the condition of orchards even in the area where trees are liable to become infested, is by no means hopeless. The Ontario Government has expert, capable and wise officials devoting their best energies to the discovery of a practical remedy; and, although, from the lack of knowledge on the part of some fruit-growers, the work of controlling the San José Scale has been much hindered by the suspension of remedial measures in 1899, at the same time, the results of experiments show that much good can be done by treating orchards if this is done systematically. This treatment, however, in the present state of our knowledge, is both dangerous and rather expensive; but the former of these drawbacks will most probably be lessened or done away with by future experimenting, and the question of expense is merely a business matter of comparing outlay with returns, the same as has to be met in every branch of a fruit-grower's or any other business man's work. It is merely a question of whether the treatment pays or whether it does not. If it can be shown that a certain expenditure of money and labour will bring a profitable return, that is all the business man has to consider.

As an illustration of this, it will be worth the while of all fruit-growers living in that part of Ontario where the San José Scale occurs, to acquaint themselves with the actual facts of the present condition of Catawba Island, Ohio, in Lake Erie. A year or two ago this island was practically one large and very prosperous peach orchard. Later the San José Scale was imported and increased to the extent that the fruit prospects of the whole island were thought to be ruined. The natural excitement caused by this state of affairs stirred up the whole fruit-growing community to the adoption of energetic measures. By the advice of Prof. F. M. Webster, whale oil soap was adopted as the universal remedy. Arrangements were made with Mr. W. H. Owen, of Catawba Island, to make a uniform grade of whale-oil soap, and this was applied to the trees throughout the island. As a consequence of this work, a large crop of fruit has been reaped from Catawba Island, where but for this concerted action only devastation and ruin could have existed. It must not be forgotten, however, that this action by the fruit growers was almost universal, and nearly every orchard was sprayed regulary and at the time advised. Now, Prof. Webster expressly states that the San José Scale on Catawba Island is by no means exterminated, but that the fruit-growers have got it under control by a persistent use of whale-oil soap. They have simply reduced the pest to a point where it can be controlled ; but, just as sure as they give over their efforts for a single year, the insect will come to the front again, and, if two or three years were allowed to pass without treatment, a great many trees would be lost.

In one particular district in Ontario the fruit-growers protested strongly against the measures adopted by the Provincial Government to control the scale, but at the same time it was found afterwards that they had done nothing to treat their trees to prevent the scale from spreading. As a consequence, during the past season this district has become one of the very worst infested. There was at one time in the United States the same difficulty in persuading fruit-growers to treat their trees. Prof. Webster in his bulletin (No. 103, Ohio Agr. Exp. Station), 'The San José Scale Problem in Ohio, in 1898,' says: 'Heretofore it has sometimes been difficult to get the owners of some slightly infested orchards to apply whale-oil soap, but this season has taught them a lesson that they will not soon forget, for, while they stubbornly refused to treat their orchards last spring, they now have the rather humiliating spectacle of trees on their own premises almost if not quite totally devoid of fruit, while their more progressive neighbours, who invested their money in whale-oil soap and applied it faithfully, have plenty of fruit and no longer fear the San José Scale. Many orchards whose owners could hardly have been induced to treat their trees last season on suspicion of the San José Scale being present, will hereafter be treated on the slightest possible suspicion of the scale being present, and the owners will do it willingly.'

Prof. Lochhead, of Guelph, who has devoted much time and attention to the question of the San José Scale in Ontario, says, under date December 22, 1900 :

'This is the cloud which is hovering over the fruit-growers of south-western Ontario at the present moment. They recognize now that the scale has spread very widely during the past season, and has also increased in intensity. They know also now that no remedy need be applied in a slipshod fashion. To my knowledge the scale is spreading from new centres not previously known. The remedies are known, but it remains for the owners of orchards to follow the prescription closely which has been given by entomologists. The nurseries will be more closely watched than ever this coming year, so that no infested stock can possibly leave the grounds.'

It will be seen from the above precautionary measures, which are being strictly enforced by both the federal and the provincial governments, that every possible effort is being made in Canada to-day to control, if possible, this terrible pest, and to prevent by every means fresh introductions. Not only is every woody-stemmed plant imported into Canada from infested countries fumigated with hydrocyanic acid gas, but every nurseryman in Ontario is forced to submit to the same treatment every shrub and tree supplied to customers.

THE PALMER WORM
(*Ypsolophus pometellus*, Harr.).

Attack.—Slender greenish white caterpillars, reddish brown on back, with a central stripe down the middle, bordered on each side with white irregular bands; when full-grown, a little over half an inch in length; feeding on the leaves, and sometimes on the surface of the fruit.

Complaints of the work of this insect have been received from several localities during the past season, particularly from sections along the northern shore of Lake Ontario. It has also been found as far north as Ottawa. Judging from reports received, the Palmer Worm has confined its attacks chiefly to the apple. From a letter received from Mr. A. W. Peart, of Freeman, Ont., dated June 19, the following is extracted:—

'I enclose in small box some worms which are very plentiful here at present, working particularly on the apple. They vary in size from a ¼ of an inch to ⅝ of an inch in length. They are a light yellow with two stripes running lengthwise on either side of the back. Their most marked characteristic is their rapid motion. Take one in the palm of the hand, and touch it, it wriggles and jumps an inch or two with rapid lightning-like contortions. When you catch one, it is hard to hold. Like the cankerworm, it spins a thread when you disturb a branch, and lets itself down, and you can see it swinging; but unlike the cankerworm, it does not loop in travelling. I find it in holes eaten in the young apples, and I think it is responsible for at least a portion of the cavity, if not all. On some trees, with their leaves badly riddled, you can find them by hundreds.'

Letters of a similar nature to the above have been received from Oakville, Adolphustown, and other points.

The life-history of the Palmer Worm is fairly well known. When the caterpillars are young they eat only the soft tissues of the leaves, but, as they mature, they devour the whole of the foliage, with the exception of the coarser veins. This is especially so when the larvæ are numerous. When the infestation is not of a serious nature, the caterpillars may be found feeding in a folded portion of a leaf. These larvæ are extremely active, and, as has been observed above, if a tree on which the caterpillars are at work is suddenly jarred, the larvæ will drop from their feeding places, and suspend themselves in the air by means of silken threads. If one is placed on any flat surface, it wriggles, and when touched moves with remarkable rapidity.

When full-grown, the caterpillar is a little over half an inch in length, and in general appearance is a greenish-white larva, with the dorsal area reddish brown, having a central dorsal stripe widely bordered on each side with white irregular bands, a little wider than the medio-dorsal stripe. The head is honey-yellow. The thoracic shield is transparent and inconspicuous, having the hind margin borderded with black for half its length, the black edge terminating with a hook forward on each side of the shield, leaving a wide central opening. The stigmatal fold is prominent. Along the dorsal area are two series of black piliferous spots, those on the anterior portion of each segment closer together than the others. Spiracles whitish, difficult to detect. The body bears a few slender bristles, one from each spot.

When mature the caterpillar changes to a chrysalis, usually in a fold of a leaf, and produces the moth in about fourteen or fifteen days. Those received on June 28 spun up on July 2, and the moths appeared on July 16 and 17. The moth is a delicate little creature of about five-eighths of an inch in expanse of wings. It is of a grayish-brown colour, with a purplish or golden reflexion; some specimens are of a tawny yellow. The forewings are dotted with small dark chocolate-coloured spots. The margins of the dusky lower wings are deeply fringed.

Remedy.—The remedy for this insect is spraying with the arsenites. A hymenopterous parasite was bred from this species by Mr. C. H. Young, of Ottawa.

THE GREENHOUSE LEAF-TYER

(*Phlyctaenia ferrugalis*, Hbn.=*Botis harveyana*, Grt.).

Attack.—Slender semi-translucent green caterpillars, when full-grown, nearly an inch in length, with two distinct black spots (one on each side) close behind the head, the green dorsal vessel showing distinctly down the middle of the back, bordered on each side with a double white band; feeding on the cellular tissue on the lower sides of the leaves. In many cases the leaves are drawn together by threads of fine silk.

In my last report the above insect was treated of at some length, and, as it is now still prevalent in the same locality (Toronto) and has appeared in other houses in Hamilton, I again draw special attention to it, for unless checked it is liable to spread and possibly become a serious greenhouse pest in Canada. In Toronto last year the larvæ did much harm, causing considerable loss to roses, but this year the species is also attacking violets and chrysanthemums. On November 12, Mr. Arthur Gibson, of this Division, paid a visit to the houses of Mr. J. H. Dunlop, Toronto, and specimens of the larvæ in all stages, pupæ and moths were found in some abundance. In one of the chrysanthemum houses especially, the insect was very prevalent and numbers of the moths were flying at the date mentioned. In this house some eggs were found, and these have since hatched in the office and proved to be the same species.* The eggs were laid on the under side of the leaves. They are flattened and remarkably like those of the Codling Moth, dirty-whitish, about one-half mm. in width, round, strikingly iridescent, the surface coarsely reticulated (which gives them a slightly roughened appearance), and are laid sometimes singly, in pairs, or in clusters of 3 to 7, the eggs of which overlap at the edges. The work of the caterpillars was only noticed on the underside of the leaves, and in the case of the mature larvæ large pieces of the soft tissue were eaten away. The caterpillars were generally found to be within a slight silken web, and in many cases two leaves were brought together and fastened by threads of silk, the larva feeding on the soft tissues on the underside of the upper leaf. The young caterpillar, as soon as it hatches from the egg, is about one-twelfth of an inch in length, and of a semi-translucent creamy-white colour, with a large black head. The body bears slender whitish hairs, and the skin is smooth and shining. After they have been feeding, the colour of the green food contents gives the caterpillars a slight greenish appearance. In the second larval stage, pale whitish stripes are present on the body, and these, as the larva passes through its other stages, become more distinct. When mature the caterpillars are about three-quarters of an inch in length, slender, semi-translucent, with the dark-green dorsal vessel showing distinctly through the skin, but rather faint on segments 2, 3 and 13. On each side is a double white sub-dorsal band which is also rather faint on segments 2, 3 and 13. On segment 2 are two distinct black spots, one on each side of the dorsal area. Head about one twenty-fifth of an inch in width, bilobed, smooth, shining, whitish, splashed with brownish blotches on cheeks and bearing a few pale hairs. Mouth parts brownish; ocelli black. Spiracles white and very small, joined by a faint whitish line. On segments 2, 3 and 4 this line is represented by a few faint white dots and is obsolete on segment 13. Thoracic feet and prolegs of the same colour as the body; the thoracic feet each bear exteriorly two black dots, one above the other. The whole body is sparsely covered with slender pale hairs, the ventral surface being lighter in colour than the dorsal. When at rest these caterpillars have a habit of curling round to the side of the body their heads and the first three or four segments. The duration of the pupal stage is from seventeen to twenty days. The moth is of a rusty-brown colour, and when the wings are spread measures a little over five-eighths of an inch in width. When at rest it measures three-eighths of an inch at widest part. The wings are crossed with darker lines and also bear darker markings.

As to remedial treatment, the picking of the leaves on which the caterpillars are at work is recommended, and in the Toronto houses good work in this direction has

* Many eggs have since been secured from moths kept in confinement.

been done; large numbers of the moths have also been dislodged from their resting places and killed. The proper carrying out of such work, however, takes up too much time, especially if many large houses have to be gone over, and, as this insect is almost continuously at work when once established, no doubt fumigation with hydrocyanic acid gas is the quickest and most effective remedy.

A GREENHOUSE LEAF-ROLLER
(*Cacoecia parallela*, Rob.).

Attack.—Dull green caterpillars about an inch in length when full-grown, with yellowish-brown head and thoracic shield ; each segment but the first two bearing conspicuous white piliferous tubercles ; feeding on the foliage of rose bushes in greenhouses, drawing the leaflets together by threads of silk, or rolling a leaf up and spinning a web inside.

In my last report I recorded the occurrence of two new greenhouse pests in Canada, viz., the Greenhouse Leaf-tyer (*Phlyctaenia ferrugalis*, Hbn.), and the Black Violet Aphis (*Rhopalosiphum violae*, Perg.), both of which occurred at Toronto. During the past year there was brought under my notice for the first time in Canada the work of another insect, attacking the foliage of rose bushes in greenhouses of Messrs. Webster Bros., at Hamilton, Ont. Specimens of the caterpillar were sent to the Division, and these have since been bred to maturity, and proved to be those of a small tortricid moth, *Cacoecia parallela*, Rob., somewhat resembling the Oblique-banded Leaf-roller, which has long been known to injure roses, particularly out of doors.

The caterpillars of *Cacoecia parallela*, Rob., were first noticed doing injury at Hamilton in June, 1899, and since then they have appeared in hundreds, causing great annoyance and damage. The larvæ were particularly prevalent during the present year, from the end of March until about the middle of October. The work of the caterpillar is much after the style of both the Greenhouse Leaf-tyer and the Oblique-banded Leaf-roller. It feeds on the green foliage and has the habit of drawing the leaflets together by means of threads of silk, or rolling a leaf over, spinning a web and feeding inside.

The caterpillar when full-grown is about one inch long ; it tapers slightly to each end and has the segments distinctly marked. The colour is dull green, overlaid lightly with velvety black, of a slightly darker shade on the dorsum. The piliferous tubercles are white and conspicuous, bristles long and slightly wavy. The head is round, slightly depressed in front, of a yellowish-brown colour, and bears some slender light hairs ; mouth parts and antennæ darkened ; ocelli black. Behind each cheek, at the back of the head, is a black elongated blotch in line with the ocelli. Thoracic shield honey coloured, with two small back spots on the front margin, divided by the pale median line. The posterior margin of the shield is bordered heavily with black, which gradually enlarges into a wide blotch towards the apex. Like the double blotch on the front margin, these blotches are separated by the median line. Below the thoracic shield are two short tubercle-like chitinous dashes, the upper of which is immediately in front of the spiracle. Each of these dashes bears a pair of bristles. The anal shield is darkened towards the apex and bears several slender bristles. The conspicuous white piliferous tubercles are arranged as follows :—The sub-dorsal tubercles are widely separated, so as to bring them and those of the lateral series almost into line. The supra-stigmatal tubercles are immediately above and close to the small, black-ringed spiracles, in some cases partially inclosing them. The infra-stigmatal tubercles are directly below the spiracles, and separated from them by twice their width. The supra-ventral tubercles lie in a line directly below those of the lateral series. There is a ventral series of large double tubercles which lie at the base of the prolegs and thoracic feet, and each of which bears two or three bristles. On segments

5, 6, 11, 12 and 13, there is beneath each segment a series of small ventral tubercles on each side of the medio-ventral line. The thoracic feet are shiny, black, white at joints, and almost ringed at the base with a narrow shiny black band, which is open on the outer side. The prolegs are concolorous with the ventral surface. All the feet bear short hairs.

When full-grown the caterpillars spin light cocoons among the leaves, two or three of which they gather together. The pupal period of specimens bred during the past season was about nine or ten days.

The moth, which, in a superficial way, closely resembles the well known Oblique-banded Leaf-roller, measures from three-quarters of an inch to very nearly an inch in expanse of wings, and in greenhouses there are several broods in the season. The colour of the upper wings is a pale brown, crossed obliquely by three bands of a much darker shade, the central one of which is clearly defined at its margins. The other two bands fill up the apical and basal areas of the wings. In many specimens the basal band is almost obliterated. The whole wing surface is loosely reticulated with indistinct basal lines. Under wings paler than the upper.

Fig. 17.—*Cacœcia parallela.* (After Prof. O. Lugger.)

Although rather smaller, this moth resembles the Oblique-banded Leaf-roller very much in general appearance, but it will be seen by the above description of the larva that these two insects are very different indeed in the caterpillar stage of their existence. The larva of the Oblique-banded Leaf-roller may in general terms be described as a green larva with a very dark brown, almost black, head, while that of the above is a blackish green caterpillar, with a yellowish head, and having the body conspicuously dotted with white tubercles.

Owing to their habits, the caterpillars are rather difficult to reach with remedies. Spraying with Paris green and water was tried to a limited extent, but it was not thought to have a sufficiently beneficial effect to continue the applications. This failure, it was claimed, was due to the way in which the caterpillars protect themselves. There is no doubt, however, that many of the larvæ were destroyed, and doubtless more would have been killed if the spraying had been continued longer at short intervals. In the above houses only two applications of Paris green were made, and as this did not appear to have good results, the caterpillars were left to themselves, and no further treatment was applied to the foliage. Late in the season (September) the moths were very numerous, and hand-picking of the larvæ was resorted to, a good sharp boy being sent through the houses early every morning to pick the caterpillars from the bushes. All the larvæ obtained in this way were burned.

Remedies.—As regards remedial treatment, of course, hand-picking of the caterpillars has certainly some beneficial result; but, as I have pointed out in the case of the Greenhouse Leaf-tyer, the carrying out of such work carefully and properly, takes up too much time, especially if large houses have to be gone over. If the infestation is light, hand-picking will probably be all that is necessary, but when the insect is at all abundant in large houses, spraying or dusting with poisonous mixtures or fumigation with hydrocyanic acid gas are the most effective remedies. Fumigation with this gas, however, must be done carefully and strictly according to instructions, and if such treatment is adopted by any one to destroy greenhouse insects, unless they are fully posted on the matter, communication should previously be entered into with this Division, when full information will be cheerfully given. Hydrocyanic acid gas is now largely used to destroy greenhouse insect pests, but its very dangerous nature must not be overlooked.

SOME INSECTS OF SPECIAL INTEREST REPORTED TO THE DIVISION OF ENTOMOLOGY DURING 1900.

(Detailed Treatment of which in the Present Report is Precluded by Want of Space.)

FODDER CROPS.

The Clover Root-borer (*Hylastinus obscurus*, Marsh,=*Hylesinus trifolii*, Mueller).—Reported at a few places in Ontario. The worst occurrences in old clover fields at London, Picton and in a small patch at Ottawa. Remedies : A short rotation and the ploughing down of infested fields as soon as there is a pretty good growth after the hay has been cut.

The Large Clover Weevil (*Phytonomus punctatus*, Fab.).—Larvæ found at Picton, Ont., on May 24, in large numbers, but so severely attacked by the parasitic fungus *Entomophthora phytonomi*, Arthur, that little injury was done.

The Green Clover Weevil (*Phytonomus nigrirostris*, Fab.).—Occurring with the last named at Picton and also abundant in clover fields at Ottawa. Remedy : Early cutting. The larvæ feed chiefly in the sheathing bases of the leaves and in the flower heads.

ROOTS AND VEGETABLES.

Cabbage Worms (*Pieris rapae*, L.).—This common enemy of the market gardener was particularly abundant in all parts of Canada this year. Reported as abundant and destructive at Kaslo, B.C., by Mr. J. W. Cockle, who observed it first in British Columbia last year. For the first time this year it appeared on Vancouver Island, and did much harm to cabbages and mignonette in gardens (J. R. Anderson, R. M. Palmer and G. A. Knight). In Ontario it was destructively numerous in the counties north of Lake Ontario, injuring the turnip crop seriously ; also reported as one of the worst pests in Nova Scotia (Harvie Gray) and parts of Quebec.

Remedy : Dusting with Pyrethrum and lime (or some other dry diluent), and spraying with arsenical poisons in turnip fields.

Root Maggots (*Anthomyia*) of Cabbages, Cauliflowers, Radishes and Onions.—Many experiments were tried with more or less success. On cauliflowers and cabbages the best results were secured by using the Gough tar-paper discs which have been reported upon previously. For the other crops, carbolized mixtures seem to be of greatest promise.

These insects are reported to have been unusually scarce at Nappan, in Nova Scotia, this season, and as a consequence good cabbages and cauliflowers were grown (W. S. Blair). At other points in Nova Scotia (K. McIntosh), New Brunswick and Prince Edward Island (Father Burke), they were as destructive as usual.

Cabbage Pionea (*Pionea rimosalis*, Gn.).—Destructive in turnip fields in Prince Edward Island (S. A. Stewart and G. F. McKinnon).

Turnip Aphis (*Aphis brassicae*, L.).—A considerable amount of harm has been done by the Turnip Aphis in a few localities, but the complaints this season have been far less numerous than has usually been the case. The worst attacks have been in the counties of Huron and Bruce, where in some sections as much as half the crop of turnips was destroyed (H. Deacon).

Remedies : Spraying with kerosene emulsion or whale-oil soap solution, 1 pound in 6 gallons of water, at the time colonies first appear in August ; also ploughing down deeply the tops as soon as cut from the roots, as the eggs were found to be laid upon these in large quantities at Belgrave, Ont.

Diamond-back Moth (*Plutella cruciferarum*, Zell.)—Very destructive in parts of Vancouver Island (G. A. Knight) and Saskatchewan (Percy B. Gregson).

FRUITS.

CODLING MOTH (*Carpocapsa pomonella*, L.).—This is still a cause of enormous loss to fruit-growers. Where systematic spraying is practised, supplemented by the banding of trees with strips of burlap or whisps of straw, the numbers have been reduced to a marked degree. Many practical fruit-growers might be cited from every province of the Dominion to prove this.

PLUM CURCULIO in Apples (*Conotrachelus nenuphar*, Herbst).—For several years this insect has been a troublesome pest in the orchard of Mr. Jack, at Chateauguay Basin, Que. In the fall of 1899 the orchard was ploughed and the land has been cultivated most of the past summer, and, as a result, no injury has been done by the curculio, except where some raspberries were left growing among the trees.

OYSTER-SHELL BARK-LOUSE (*Mytilaspis pomorum*, Bouché).—There is probably no orchard pest in Canada which is wider spread than this and which has destroyed more trees. A practical remedy has long been a desideratum. The standard remedy, up to the present time, has been the kerosene emulsion ; but this has never been popular, owing chiefly, I think, to the trouble of making it and its destructive effects on rubber hoses. About five years ago it was noticed that trees sprayed with Bordeaux mixture were freer from this insect than those which had not been sprayed. This was due, it was thought, to the deposit of lime from that mixture which was left on the trees.

In the course of some experiments made on apple trees which happened to be badly infested with Oyster-shell Bark-louse on the Experimental Farm by Mr. W. T. Macoun, by spraying with a lime whitewash to retard the opening of flower-buds as a protection against late frosts, it was discovered that these whitewashed trees were very much cleared of the Oyster-shell Bark-louse, and subsequent experiment shows that this is probably an easy, cheap and effective remedy against this pernicious insect. The best time to apply the whitewash is late in the autumn, so that the scales loosened by the wash may be scaled off with the lime during the winter. Spraying trees during the winter is a very unpleasant operation, so this work should be done during the warm days of November, and the strength of the whitewash which has been found effective is from one to two pounds of lime in each gallon of water. A better coating of lime is deposited on the trees if two applications are made, the second being applied as soon as the first one is thoroughly dry.

Applications of concentrated lye, as supplied in tins for household uses, were also experimented with in varying strengths from 1 pound in 3 gallons of water, up to 1 pound in 6 gallons ; but they were not sufficiently fatal to the scale insects to justify their recommendation. Even at the strength of 1 pound in 3 gallons, although the leaves of some plants were spotted, no permanent injury was done. All the samples of concentrated lye which were obtainable were found to be caustic soda.

THE PEAR-TREE FLEA-LOUSE (*Psylla piricola*, Foerster).—This insect is widely spread through the pear orchards of western Ontario, but seldom occurs in large enough numbers to attract attention. It is, however, a pest which pear-growers should watch carefully, and treat promptly if the numbers increase. Mr. George E. Fisher, a most accurate observer, with exceptional opportunities of examining orchards, writes : 'On several occasions I have noticed Pear Psylla doing very serious damage to pear orchards. When once established it multiplies very rapidly. Here at home a number of years ago I had 300 Dwarf Duchess trees badly infested, and even now, after spraying regularly, they do not seem to have fully recovered. My neighbour, Mr. J. S. Freeman, had a block of 400 Dwarf Duchesses so badly attacked that nearly all died. In 1899, Mr. E. J. Henry, of Winona, had an orchard badly affected. I am fully persuaded that this is not an insect to trifle with, but I do not dread it as much as I did, for I now know that by the use of an emulsion of crude petroleum and whale-oil soap I can destroy such insects as winter exposed on the trees. For Psylla one must

operate early, because the eggs are laid early. In May, 1899, I visited a large Dwarf Duchess orchard belonging to Mr. Henry Lutz, of Youngstown, New York State. In 1896 this block of trees had been almost ruined by Psylla. In February, 1897, the whole block was sprayed heavily with lime, which destroyed the insect so completely that when I saw the trees two years after they appeared very healthy indeed.'

THE RED-HUMPED APPLE-TREE CATERPILLAR (*Oedemasia concinna*, S. & A.).—Specimens of these caterpillars were sent from Kaslo, B.C., by Mr. J. W. Cockle. They were very prevalent at the time in apple orchards.

THE PEAR-LEAF BLISTER MITE (*Phytoptus pyri*, Sheuten).—Several inquiries about this have been received from British Columbia. Mr. Palmer reports: 'This insect continues to be a very persistent pest, and is quite generally distributed through the province. It is easily kept down by the use of the lime, salt and sulphur spray used in winter, but is difficult to exterminate and will reappear if spraying is neglected.'

THE BLACK VINE WEEVIL (*Otiorhynchus sulcatus*, Fab.).—Occasional references to injuries by this beetle have been made, chiefly to garden plants and in greenhouses in British Columbia. The beetle is not uncommon on the sea shore in Nova Scotia, but no injury to crops of any kind has ever been reported from that province until the past season, when specimens and an account of serious injury were received from Mr. J. H. Churchill, of Westport, N.S. Strawberry beds have been injured for many years, and among the samples received were several plants which were attacked, not only by the Black Vine Weevil, but also badly by the Strawberry Root-borer (*Anarsia lineatella*, Zeller), fortunately an uncommon enemy in Canada. This injury has been going on for about six years, during which time Mr. Churchill estimates his loss in strawberries at $1,500. In British Columbia, Mr. Tom Wilson, of Vancouver, observed another occurrence of the Black Vine Weevil, where considerable injury was done to strawberry plants and primroses. In Europe this beetle is known to be a troublesome pest of grapes, strawberries, raspberries, mangels and primroses, but up to the present time nothing of importance has been recorded against it on this continent. The strawberry plants sent by Mr. Churchill from Nova Scotia on July 8, contained grubs and pupæ of the beetles, and in another parcel received on September 19, there were grubs, pupæ, and beetles, some of the latter being immature, but a few perfectly coloured. The only remedy which can be suggested for this beetle as yet is the planting of strawberries in new ground, and frequent renewal of the beds, the worst injuries being done to old plants.

In this connection I may add that Mr. W. T. Macoun, the Horticulturist of the Central Experimental Farm, tells me that he considers the single crop method of growing strawberries the one which pays best, the fruit being finer and the land being kept clean much more easily. Some varieties which do not make runners freely should be left for two years.

Nepticula (Micropteryx) pomivorella, Pack.—This interesting little insect has been more than usually abundant in western Ontario during the last two years, and a large series of specimens have been reared. The larva is a leaf miner, but when full grown, leaves the mines and spins small cocoons on the twigs of apple trees, in which it passes the winter. It has been lately discovered by Mr. A. Busck, of Washington, that this insect, which was described as a *Micropteryx*, is a true *Nepticula*.

THE LESSER APPLE WORM (*Semasia prunivora*, Walsh).—Mr. R. M. Palmer reports that this insect occurred in nearly all the fruit-growing districts of British Columbia excepting the Okanagan valley, but in smaller numbers than in 1898-9. He draws attention to the fact that this pest is still often mistaken for the true Codling Moth, by fruit-growers, but he is pleased to report that the latter has not occurred in any part of the province, although watched for carefully. A most rigorous inspec-

tion is maintained of all fruit coming into the province, so as to prevent its introduction by that means.

THE APPLE FRUIT MINER (*Argyresthia conjugella*, Zell.) appeared in small numbers on Vancouver Island during July, but no instance of its presence in large numbers was reported.

THE MEALY PLUM APHIS (*Hyalopterus pruni*, Fab.) was very prevalent in many parts of British Columbia. Spraying with whale-oil soap and quassia proved an efficient remedy.

THE MEDITERRANEAN FLOUR MOTH (*Ephestia kuehniella*, Zell.).—A mill badly infested with this insect, near Ottawa, was fumigated with sulphur with satisfactory results. An interesting observation was that the larvæ were largely parasitized by a small hymenopterous insect, which has been found by Mr. W. H. Ashmead to be a new species, and has been named by him *Idechthis ephestiae*.

THE RED TURNIP BEETLE (*Entomoscelis adonidis*, Fab.).—This native beetle, which is bright red with three black stripes down its back and a spot on the collar, and is ⅜-inch long by ¼-inch wide, was very abundant in the North-west Territories and parts of Manitoba last year. Several inquiries were received concerning its habits, and it was observed almost everywhere during July, chiefly upon cruciferous weeds, but also on turnips, radishes, &c. Upon a piece of neglected summer-fallow at Kinistino, Sask., it was seen in thousands upon the steeple-like plants of the Gray Tansy Mustard (*Sisymbrium incisum*, Engl., var. *Hartwegianum*, Watson) and upon *Erysimum parviflorum*, Nutt., and *Erysimum asperum*, DC., a near relative of the garden wallflower. This insect has been treated of at length in my report for 1892.

'Strathcona, Alta., June 1.—I send you some beetles which are abundant, climbing up the stems of some weeds on about half an acre of timothy; they come out of the ground, which I dug up and found the holes about ½ to ¾-inch deep. Are they likely to hurt the timothy? I have seen them before, but not so plentiful as now.'—THOMAS DALY.

'Strathcona, June 12.—I send a sample of a beetle which has been doing great damage in my garden, attacking wallflowers and stocks, all young plants; they are now on my turnips, radishes and cabbage. I have killed probably 1,000. What are they called, and what is the best remedy?'—JOHN H. WILSON.

'Souris, Man., September 13.—I am sending an insect which is doing much damage in gardens in the Souris district, especially at this time.'—ROBT. I. CRISP.

This beetle, both as a grub and in the perfect state, attacks all cruciferous plants. The best remedy is to spray or dust the plants attacked with arsenical poisons in the same way as for the Colorado Potato Beetle. The grubs are nocturnal in their habits, and are seldom seen.

This is also a European insect, but there is hardly a doubt that it is a native species in the North-west. In certain seasons it is very abundant, and may at any time develop into a serious enemy of the agriculturist. It belongs to the Chrysomelidæ, the family to which also the Colorado Potato Beetle belongs.

THE ASPARAGUS BEETLE (*Crioceris asparagi*, L.).—The Asparagus Beetles, treated at some length in my last report, have occurred again in the Niagara district during the past season, but do not seem to have been the cause of much injury. However, their attacks have been supplemented by another enemy, the Asparagus Rust (*Puccinia asparagi*, DC.), and one of the Hemiptera (*Cosmopepla carnifex*, Fab.) was found upon asparagus by Mr. Frank Arnold, at Queenston, Ont. These clustered on the plants in very large numbers during the last week of July. No special injury was noticed at that late date, and it was not thought worth while to advise any remedial treatment. Spraying with either kerosene emulsion or whale-oil soap would doubtless destroy them, should they at any time prove troublesome.

THE SQUASH BUG (*Anasa tristis*, DeG.).—This troublesome enemy of the gourd family is a regular pest in western Ontario, but is seldom heard of in the eastern counties. In the last week of June specimens were sent from Inverary (Frontenac Co.), Ont., by Mr. Alex. Ritchie, with the complaint that they were destroying his squash, pumpkin and cucumber vines. The remedies recommended for this insect are :—

Fig. 18. —Squash Bug.

1. Hand-picking, which is claimed to be the most practical remedy. This is done early in the morning, during the cooler hours of the day, while the bugs are sluggish.

2. Traps. If shingles or short pieces of board are placed among the plants, the bugs will hide beneath them at night, and can be destroyed before they become active and leave these retreats the next morning.

3. The young bugs can be destroyed by spraying with kerosene emulsion or whale-oil soap.

ARMY WORMS IN WINTER.—A rather curious occurrence of the Army Worm in winter took place at Alberton, in Prince Edward Island, last February. This was reported to me by my esteemed correspondent, the Rev. Father Burke, of Alberton, who also sent specimens for identification from the farm of Mr. John T. Weeks, of the same place. The occurrence is described by Mr. Weeks, as follows :—

'Alberton, P.E.I., February 17.—I am in receipt of your letter of 8th instant, and am surprised to know that we have such a pest in our midst. The specimens I sent were supplied by my brother. He is going to try and get you some more specimens, and if he is successful he will forward them in the way you suggest. He says he saw them as he drove across several farms, and they were quite a long distance from bare ground.'—J. T. W.

'February 19.—This morning my brother came in with some more of the army worms. I am sending them in a tin box with some moist earth and some grass. These are much larger than the first I sent, but among the lot are several very small ones, which are apparently dead ; but I send them so that you may see the different stages of development. My brother tells me he saw them on at least half a dozen farms, and would have had no difficulty in picking up a hundred. We had an easterly snow-storm all day yesterday, which will probably cover them up again. I fear they seem to be pretty well distributed. To what extent are they known in Canada ? What is the remedy ?'—JOHN T. WEEKS.

In reply to these letters it was explained that the Army Worm passed the winter partially grown, in a torpid condition, near the surface of the ground, and that there were previous instances where they had appeared suddenly on the surface of snow during winter. It was suggested that this appearance in winter might prove beneficial, because many thus disturbed in winter perished. The distribution of the species in Canada was given and reports of this Division were sent, in which the usual remedies are stated.

In a report on the insect injuries of the year, Father Burke informs me that no injury whatever by the Army Worm was noticed during the past season.

THE BLACK BLISTER BEETLE (*Epicauta Pennsylvanica*, DeG.).—Injuries to potatoes by the Black Blister Beetle are reported from Dugald, Man., by Mr. Kenneth McLeod, from different parts of Ontario by Mr. C. W. Nash, of Toronto, and from Inverary, Ont., by Mr. W. T. McClement, who had also found them on the farm of Mr. John Guthrie, of Perth Road (Frontenac Co.) Ont., where, he says, they ate the tops of potatoes very cleanly, and were very active. If plentiful in a district, they would be worse than the Colorado beetle, for they are much more active. They flew ahead of the poison-can and ate the tops which were not poisoned, avoiding those dusted or sprinkled, and clustered thickly on the clean tops. They were plentiful about July 25. They were not widespread, but troubled only a few fields, and these near together.

The habits of Blister Beetles were explained to these correspondents, and also the connection of these insects with various species of locusts, upon the eggs of which the larvæ are predaceous parasites.

Specimens of an allied western species, *Cantharis cyanipennis*, Say, were also sent from Ducks, B.C., by Mr. Hewitt Bostock, who had found them injuring pea-vines in his orchard.

THE APIARY.

As in previous years, the sole management of the Apiary has been in the hands of Mr. John Fixter, the Farm Foreman. The season of 1900 has been a particularly poor one in the greater part of Ontario, but by the exercise of care and attention the colonies were housed in good condition, and as far as can be judged at this date are wintering well. Several meetings of bee-keepers were attended by Mr. Fixter, and addresses were delivered by him on practical apiculture, which were highly appreciated by his hearers. I myself had the pleasure of attending the annual meeting of the Ontario Bee-keepers' Association, at Niagara Falls, Ont., on December 5 and 6, and by request gave an address upon the Fertilization of Flowers by Bees. There was an interesting discussion upon the question whether bees could injure ripe fruit before the skin was broken ; careful experiments were cited showing that this was not the case, though bees will sometimes take advantage of a crack in the fruit or of an opening made by wasps or other insects, and will suck the juice.

REPORT OF MR. JOHN FIXTER.

Experiment in Feeding Sugar Syrup for Winter Stores.

During the winter of 1899, and the spring of 1900, great trouble was experienced with dysentery among bees in many parts of the country. The disease was thought to be due to food or honeydew gathered in the autumn. An experiment was started last autumn with four colonies. All the natural stores were extracted on September 17. A Miller feeder was placed in an empty section super, close to the top of the brood frames, any part of the brood frames not covered by the feeder being covered with a propolis quilt cut so as to allow the bees a passage through it or on its side. By keeping the feeder well packed, except where the bees enter, the heat is kept in and at the same time the bees cannot daub themselves with the liquid. In this experiment the bees had a constant supply of syrup. This syrup was made of the best granulated sugar, two parts to one part of water by weight. The water was first brought to a boil, then the boiler was set back on the stove and, the sugar having been poured in, the mixture was stirred until the sugar was all dissolved. This syrup was supplied to the bees at about blood heat.

At the beginning of the feeding the average weight of the hives and colonies was 33½ pounds, and at the close 52½ pounds. It required 80 pounds of sugar to make up the weight of the four colonies to carry them through the winter and spring successfully. The weight of water used to make the syrup should not be taken into account, as it is afterwards all evaporated during the winter.

Experiments in Wintering, 1899-1900.

Experiments in wintering bees were continued in the cellar, in a root-house, in the house apiary and in a pit dug in a hill side. The results were very much the same as those described in the report for 1898 (at page 213).

THE SEASON OF 1900.

March 10.—The temperature being 41° Fahr., and the day bright and calm, eighteen colonies were removed from their winter quarters; of these six were again placed in the exposed apiary, when there was about 18 inches of snow on the ground; six were placed in the sheltered apiary, where there was also considerable snow; and six were placed in the house apiary. As soon as they were settled on their stands, the bees all began to fly at once, the weather being fair and calm. They were thus enabled to cleanse themselves and return; the snow was discoloured for a considerable distance around the hives. Very few bees were noticed which were unable to return.

March 31 and April 1 being fine and warm, the colonies of all three apiaries had good cleansing flights. From April 2 to 6 there was very little flying, the weather being cool and windy. On April 7 the bees in the house apiary and in the sheltered apiary were flying well, while those in the exposed apiary could scarcely be seen to move out.

The balance of the colonies were taken from their winter quarters on April 8, the temperature being 44°. The weather was too cold for the bees to come out to have a cleansing flight until April 11, when the temperature rose to 54°, and all began to fly. The colonies first set out were flying as well as is usual in the month of May.

From April 11 to 18, there was very little flying, on account of cool winds and wet weather.

On April 18 an examination was made of the colonies set out early in the different apiaries, and of those set out later, that is, at the usual time; the purpose being to find out whether any difference could be seen as to the strength of the colonies. In every instance, we found that those set out first, more especially those in the house and sheltered apiaries, had more brood and eggs, and appeared to be very much more active than those set out later. When once they get a good cleansing flight, whether through activity or from getting water, whatever may be the cause, more brood and eggs are found in the hives. I would advise setting the bees out just as soon as they can fly out safely. The colonies which are set out a few days earlier will be by so many days further advanced at the beginning of the honey flow, that is, those set out later will require so many days more to become as strong after the beginning of the honey flow.

On April 18 the temperature went up to 69°. The snowdrops and squills blossomed, and the bees were seen to work on them at once. On April 20 and 21, the swamp willow, soft maple and Manitoba maple came into bloom. This time would have been too late for the removal of the bees from their winter quarters, for they would before this have become restless; many would have left their hives and been lost on the cellar floor.

From April 19 to 25 the bees were seen gathering pollen or sap running from the trunks of hard maple trees that had been injured.

April 26.—Very high wind, increasing to a hurricane in the afternoon—the day of the big Hull and Ottawa fire.

April 27 to May 7.—Weather very fine; all colonies working well, gathering pollen and honey. Every colony was building up rapidly.

At this time, and also from the blossoming of fruit trees to that of clover, the greatest care is necessary, so that there may be no check in brood rearing. When the queen stops laying, or when starved brood or dead larvæ are observed in the hives, many beginners, and even many experienced men, imagine that the cause is some disease, and at once send for the Inspector of Foul Brood. An instance of this is given on a later page (Appendix A), with the answer of the Inspector of Foul Brood (*see* page 247).

May 8-10.—Very cold winds; scarcely any flying.

May 11-16.—Very fine weather; bees working well.

May 17 and 18.—Very dull and cold; scarcely any flying.

May 19 to June 7.—The bees gathered a great amount of pollen, but very little new honey; nearly every hive was full of brood and young bees.

The first drones were noticed on May 28. A considerable amount of honey and syrup was fed from May 1 to June 8 in order to keep up brood-rearing and to prevent starving.

On June 7 and 8, White Dutch Clover and Alsike came into bloom, and there were many flowering trees and shrubs in bloom, but there was very little increase in honey.

June 8 to July 15, the bees gathered a small amount of honey from clovers and basswood.

On July 15 the first honey was taken off; bees were very thick on flowers; but there was very slight increase in weight of hives during the latter half of July.

After August 3, the bees gathered very little honey, and there was no increase in weight of the hives. The autumn flowers gave no surplus, and, there being no buckwheat sown in this district in 1900, no honey was gathered from that source.

September 1 to 10.—All colonies and hives were weighed in order to ascertain how much they had lost or gained. They were weighed again on October 1 and on November 12, just before they were put into their winter quarters. Any colony and hive found to weigh less than 50 pounds on September 1 was either given full frames of sealed honey or fed syrup to make up the difference in weight. While our experiments show that each colony consumes only from 9 to 14 pounds during the winter, it is a very wise policy to have 10 or 15 pounds extra in each hive to be used in spring before the honey flow.

Average weight of forty colonies and hives:

On October 1, 51¾ pounds.
On November 12, 49 pounds.

The forty colonies had therefore lost altogether 110 pounds. The greatest loss of any colony was 4½ pounds, the smallest ½ pound.

All were put into winter quarters on November 12.

LIST of Plants, Trees and Shrubs on which the bees were seen working well during the summer, and dates at which the visits were first noticed.

April 18—Snowdrops and squills.
" 20—Manitoba maple and soft maple.
" 21—Willows in swamps and on lawns.
May 10—Tulips.
" 11—Plum and apple trees.
" 12—Dandelions.
" 19—Wild black cherry tree.
" 22—Grape hyacinth.
" 22—Garland Flower *(Daphne Cneorum)*.
" 23—Vinca, several varieties.
" 23—Anemones and alpine poppies.
" 23—*Adonis vernalis.*
" 23—*Doronicum Caucasicum.*
" 24—Sand cherry.
" 24—Currant bushes.
" 24—Siberian Pea-tree *(Caragana)*.
" 25—Pear and cherry trees.
" 25—Lilacs, several sorts.
" 25—June berry.
" 25—Polemoniums.
" 27—Pæonies and Irises.
" 29—Honeysuckles and barberries.
" 31—*Pyrus baccata.*
" 31—Mountain Ash.
June 1—Strawberries.
" 2—Buckthorn bushes and hedges.
" 4—Forget-me-not.
" 4—Ginnalian maple
June 4—Rhubarb.
" 4—Mountain Centaury.
" 4—*Ajuga Genevensis.*
" 4—*Anemone narcissiflora.*
" 7—White Dutch clover.
" 8—Alsike and sainfoin.
" 8—Raspberries and blackberries.
" 8—Sharp-leaved common Cotoneaster.
" 8—Alliums.
" 8—*Rosa rugosa.*
" 8—*Spiræa VanHouttei.*
" 12—Golden-leaved Spiræa.
" 12—Highbush Cranberry *(Viburnum Opulus)*.
" 14—Geraniums.
" 14—Wild vetch.
" 19—Large red poppy.
" 19—Strawberry-flowered Cinquefoil.
" 19—*Lupinus.*
" 21—Golden Groundsel.
" 21—Wild Mustard.
" 21—*Dictamnus.*
" 23—Locust.
" 23—*Rosa multiflora Japonica.*
" 24—English horse beans.
" 28—Broad-leaved Bellflower.
" 28—*Anchusa altissima.*

July 1—Sweet clover (*Melilotus albus*).
" 8—Asparagus.
" 8—Grass Peas.
" 8—*Lathyrus sylvestris Wagneri.*
" 8—*Eremurus altaicus.*
" 8—*Sedum Kamischaticum.*
" 8—*Thalictrum aquilegifolium.*
" 11—Basswood.
" 14—Lilies, different varieties.
" 14—*Veronica*, different varieties.
" 14—Mulleins.
" 15—Double Queen of the Meadow.
" 15—*Linaria.*
" 15—*Asclepias tuberosa.*
" 15—*Agrimonia.*
July 18—Mignonette.
" 23—*Hypericum Kalmianum.*
" 27—*Echinops Ruthenica.*
" 28—*Lychnis.*
" 30—*Solidago.*
Aug. 9—Button Bush (*Cephalanthus occidentalis*).
" 9—Pumpkin.
" 9—Late-sown English horse beans.
" 11—Campanulas and Rudbeckias.
" 21—Sunflowers.
Sept. 1—Wild Asters.
Oct. 4—African Marigold.
" 4—Gaillardias.

Experiments with Comb Foundations in Sections.

As there has been in connection with the production of comb-honey a difference of opinion as to the proper size of foundation to use, a thorough test was made with comb foundation of different sizes in the sections.

The results show that it is of great importance that the sections should be filled up to the sides and bottom with comb foundation. On examining the different sections in this experiment, it was found that the smaller the piece of foundation was, the more holes or gaps there were around the comb in the sections, and the comb was thus less firmly fastened around the sides and bottom to the wood.

The following sizes of comb foundations were tested :—

1. Full sheets fastened at the top and fitting closely to the sides and down close to the bottom.

4. Two inches square in centre of top section.

3. Quarter sheets across upper end.

4. Two inches square in centre of top of section.

5. One inch square in centre of top of section, besides a narrow strip of about half an inch across top and bottom.

6. No foundation at all.

From past experience, I would recommend that full sheets be always used. The bees worked on the full sheets first, and these were filled more evenly and very much better.

Many inquiries are made why bees will not work in supers, when the other colonies in the same apiary are working on drawn combs in extracting frames. The explanation is that the pieces of foundation in the sections were too small. Many bee-keepers, even experienced bee-keepers, do not put much foundation in the brood chamber when hiving new swarms, though they put full sheets in the supers ; consequently, the bees fill the sections in the supers first.

The experiment with different makes and sizes of hives was not completed owing to the very poor season.

House Apiary.

The House Apiary has again been tested and has worked very satisfactorily, as far as summer management is concerned ; but, for wintering, every one of the past six winters it has proved to be a failure.

Returns.

The experience of the past season has been a repetition of that of 1899. Reports from most parts of Ontario and Quebec show that there has been a very poor honey

flow, poorer even than 1899. In many places no surplus was secured, and bees have had to be fed more or less during the autumn.

Swarming was also poor on account of the shortage of honey. All the swarms that came out at the Experimental Farm Apiary were made to go back to the mother hives or were put with weak colonies; 18 of the old colonies were doubled up, leaving now on hand 42 colonies.

The returns from the experimental apiary show an average of only 13 sections per colony. The colonies which were run for extracted honey gave 19 pounds per colony.

JOHN FIXTER.

APPENDIX A.

An Ontario bee-keeper wrote as follows to Mr. Wm. McEvoy, Inspector of Foul Brood for Ontario :—

'Dead brood appeared in half of my colonies. There would be from one to five or ten dead larvæ in a colony, and some of these I often found in capped cells, when I opened them with a penknife.

'I tried the starvation plan. Several of the colonies I starved twice, as the larvæ continued dying. I even destroyed two sets of foundation. Just think of the time and patience required to look into every cell in 80 colonies; this I did several times. I had made up my mind to clean them up. I have melted many a score of white combs and super combs. I wish to be first on your list for inspection next summer. I may buy a lot of colonies which will be subject to your inspection.'

Mr. McEvoy's answer is full of valuable information :—

'Your colonies ran out of unsealed honey while they had a large quantity of brood on hand to feed, and then your bees did not uncap the sealed stores fast enough to keep pace with the amount of brood that required feeding, and the result was that considerable brood died of starvation. And some time after that the brood would suffer in proportion to the length of time that the brood nest was short of unsealed stores, and it would end in an increase of starved brood, which the bees would allow to remain in the combs for some time after the honey flow commenced. You never would have found one cell of dead brood in any of your colonies if you had kept them well supplied with unsealed stores. You may say that I am very much mistaken as to the cause in your case, but I am not; I have travelled over every inch of this line for fully twenty years and from close observing, feeding and watching results, I have found that such is the cause why the bees fail to feed all the brood at certain times.

'On the night of May 28, 1889, we had a killing frost all over the province of Ontario, which was followed by several days of wet weather. That frost coming at the end of one of the warmest and most favourable springs ever known for bees, was a serious thing, because it caught all hives full of brood and suddenly stopped all the honey flow at the time when every colony had an immense quantity of larvæ to feed. I warned every bee-keeper at that time that he could look out for a wholesale starvation of brood and a very small crop of honey if he did not go to work and feed his bees so as to give them a chance to feed the larvæ. I kept my brood chambers well supplied with unsealed stores (through uncapping and feeding) until the honey flow began again. By thus doing, I secured one of the largest yields of honey I ever took, and I did not see one cell of dead brood. Late in the summer of 1889, many a bee-keeper became very much alarmed when he found his brood chamber in a rotten state with dead brood. Spraying of combs, starving the bees, and other methods were resorted to, to stamp out the dead brood. If these men had gone to work right after that great frost of May 28, and kept the brood chambers well supplied with unsealed honey through uncapping a part of the old sealed stores at one time, then another afterwards, and so on until the honey flow began again, they would have had

the most of the old honey used up and more space filled with brood: at the same time they would have had an increase in the number of the bees and would have secured a much larger yield of honey; there would have been also no dead brood. The very wet weather that set in all over the province in the last half of May and first week in June, was very hard on the constitution of thousands of colonies, because it prevented any honey gathering during that long rainy time, and after the bees used up the unsealed honey (a thing they always use first) they did not uncap the old sealed stores fast enough to keep pace with the large quantity of larvæ that required feeding; the result was a lot of starved brood, weak colonies and a small honey crop in many places. During the three weeks of wet weather I kept my colonies well supplied with unsealed honey by uncapping the sealed stores from time to time until all was used up, and after that I fed the bees until they commenced to gather honey. When the honey season opened, the combs in every brood-chamber were full of brood, and a large number of bees were hanging out on the front of every hive. I then put supers on, and from ninety colonies in that off season I took over 10,000 pounds of clover honey and left abundance for the bees to winter on. Last season I kept my colonies supplied with unsealed honey between fruit bloom and clover bloom, and when I finished extracting the balance of my crop in the fall I found I had taken over 11,000 pounds of clover honey from 100 colonies, and left plenty to winter the bees. You say that you tried the starvation plan and the dead brood showed up again; also that you starved several of them twice. I am certain that dead brood (starved brood) would not have shown up again after you put the bees on foundation, if you had fed the bees freely until they began to gather honey. You also say that many a score of white comb you melted. What a loss! These beautiful combs should not have been melted. With different management you could have made $250 or more, and saved all the combs and yourself from a world of worry.'—J. McEvoy.

WEEDS.

SPRAYING FOR DESTRUCTION OF MUSTARD.

In my last report an account was given by Mr. Frank T. Shutt, M.A., F.R.S.C., Chemist to the Dominion Experimental Farms, of some experiments carried out by him, with the assistance of the Horticulturist of the Central Experimental Farm, to test the efficacy of the French method of eradicating Wild Mustard by spraying infested growing crops with solutions of copper sulphate. The conclusion arrived at from these experiments was, that a 2 per cent solution of copper sulphate, applied at the rate of 50 gallons to the acre, when the mustard plants were young, was the most effective, safest (as regards the grain crops) and most economical to use. The average cost of this application would be $1 per acre.

During the past summer, the Horticulturist, having men and horse-power at his disposal, again tested this remedy, and the results were again successful, although the experiment was carried out rather late in the season, and under certain other disadvantages as to the nature of the crop infested and the weather which prevailed at the time.

Mr. Shutt has drawn my attention to an important article on the subject, entitled 'The destruction of Charlock,' by Dr. J. Augustus Voelcker, in the Journal of the Royal Agricultural Society of England, vol. X, pt. 4, pp. 767-775, which, on the whole, confirms Mr. Shutt's conclusions and gives much valuable information on the subject. One quotation from a report made by Mr. Wm. Carruthers, the Consulting Botanist of

the Royal Agricultural Society, on some of the experiments referred to, is of particular interest to Canadian experimenters, who have been disappointed at the results sometimes obtained when spraying has been tried for the destruction of mustard in districts where the Bird Rape (also called Kale, or Smooth-leaved Charlock) is abundant. This is particularly the case in Manitoba, where by far the greater proportion of the plants called Wild Mustard are really Bird Rape *(Brassica campestris,* L.) 'I have not been able to detect anything in the structure of the Charlock that should make it so readily a prey to the copper sulphate. This is still more remarkable when we find that it does not in the least injure another species in the same genus, which in Cumberland is known as the "Smooth-leaved Charlock." This plant, the *Brassica campestris* of Linnæus, is very common in some districts. A correspondent in Cornwall writes that it is very common in his county. He has observed that while the common Charlock is easily destroyed by copper sulphate, the smooth-leaved plant is quite uninjured by it. This is probably the explanation of the difference in the testimonies as to the influence of copper sulphate on Charlock. The two plants so closely resemble each other that only a careful observer can distinguish that they differ. The true Charlock *(Brassica Sinapistrum,* Boiss.) is destroyed by treatment, while the smooth-leaved Charlock (*Brassica campestris*, L.) is not affected.

'As the general outcome of Mr. Hornsby's experiments, it would seem that for Charlock when still young, 40 gallons per acre of 2 per cent solution of sulphate of copper would be found effectual, but that, if the Charlock were already in flower, as much as 60 gallons of a 4 per cent solution would be required.'

AUTHOR'S EDITION

FROM ANNUAL REPORT ON EXPERIMENTAL FARMS FOR THE YEAR 1903

CANADA

DEPARTMENT OF AGRICULTURE

CENTRAL EXPERIMENTAL FARM

REPORT OF THE ENTOMOLOGIST AND BOTANIST

(JAMES FLETCHER, LL.D., F.R.S.C., F.L.S.)

1903

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REPORT

OF THE

ENTOMOLOGIST AND BOTANIST

(JAMES FLETCHER, LL.D., F.L.S., F.R.S.C.)

1903.

OTTAWA, December 1, 1903.

Dr. WM. SAUNDERS,
Director of Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to hand you herewith a report on some of the more important subjects which have been brought officially under my notice during the past season.

The appreciation of the value of the investigations prosecuted by the officers of the Division is indicated by the large correspondence with farmers, fruit-growers and others in all parts of Canada. It is impossible in an annual report to deal with all the subjects which come up for consideration during the year. Many of these have already been treated of in previous reports, and the investigation of some is as yet in an incomplete state. Correspondents are constantly adding much to previously recorded facts concerning the habits of injurious insects, the utility of remedies, and the best way to apply them, the value of fodder crops, and many other subjects. The correspondence and replies relating to these are all carefully preserved and classified for future use. A complete index has been made of all letters which have been sent out from the division since the institution of the Experimental Farms up to the present time, which is of much use when working up afresh a subject which has been previously studied.

Fodder Plants.—The testing of grasses and other fodder plants, native and exotic, both in the experimental grass plots at the Central Experimental Farm and by correspondents, has been continued, and, as in the past, has been a source of much interest to all who have witnessed these experiments. The Awnless Brome Grass, the cultivation of which, from its introduction up to the present time, I have persistently endeavoured to encourage, has proved a great boon to farmers and stockmen in Manitoba and the North-west Territories. This grass is now recognized as one of the important staple crops of the West, where it is grown both for hay and pasture, as well as for the seed, which always meets with a ready sale. Attention has also been drawn to the value of various mixed crops for summer feed, and, following the experience of our Superintendents at the western farms, some farmers have grown with great satisfaction mixtures of pease, oats and wheat, one bushel of each to the acre; tares and oats, or pease and oats, one and a half bushels of each to the acre.

Lucerne or alfalfa has been tried to a certain extent in most of the provinces of the Dominion, and where care has been taken to prepare the land properly by ploughing deeply and then consolidating and smoothing the surface by harrowing, it has done

well in many localities where it had been thought previously that this most valuabl clover would not grow. It is also most important that the land should be in the con dition known by farmers as 'good heart,' that is, fit to grow a good crop of an ordinar farm crop. I feel confident that this fodder plant, which is of such immense import ance in the semi-arid districts of the western States, both on ordinary farm land an under irrigation, is worthy of a much more extensive trial in the North-west a Manitoba than up to the present it has received. This, to a large measure, is also case with the other well known clovers so extensively cultivated in the East, but w are considered out of the question as farm crops on prairie farms. All of these clover may be found in many places along railway banks throughout the West, and, wher they have been tried on farms, although the general result has been considered a fail ure, still there are many plants persisting and in some places increasing slowly yea by year. It is now well known that the satisfactory cultivation of clovers is muc affected by the presence of bacteria-containing nodules upon the roots, and that, if thes be present in the soil, the vigour of the plant is much increased. This increase take place more and more every year when clovers are grown upon new soil, the origina bacteria, adjusting themselves to the clovers from nodules on roots of native leguminou plants, or, possibly, being carried with the seed. White Clover is thoroughly establishe in the streets of Winnipeg and some other Manitoban towns, where it is sown to crow out coarse weeds along the boulevards and in the streets. This plant grows well als at Regina, Calgary, and many other places. Mr. Bedford, the superintendent of th Manitoba Experimental Farm, writes:—'On this farm, when sown without a nurse crop Alfalfa, Common Red, Mammoth Red, Alsike and White Dutch Clovers form robus plants by fall, and do not fail to pass the winter successfully. I sow in spring withou a grain crop, because, when sown with grain, alfalfa and other clovers, but particularl alfalfa, have been winter-killed, the roots produced during the first year being smal and short. I have grown alfalfa since 1887.'

When travelling through the North-west Territories, I have frequently come acros farmers who have small patches of alfalfa, some of these of three or four years' standing and Mr. T. N. Willing, of Regina, who, as Provincial Weed Inspector, has exceptiona opportunities of seeing what crops are grown on farms in all parts of the North-wes Territories, and who, as a practical farmer, is well able to judge the value of crops writes:—'I am sorry to say I am not aware of any one who is conspicuously successfu with alfalfa on a large scale, although many have tried small patches, which hav apparently given most promising results. Mr. W. Stevens, of Cloverbar, near Edmon- ton, has a patch in its second season, which wintered perfectly; when mowed at th end of July it was between three and four feet high and gave a crop estimated at from three to three and a half tons. Near Battleford, the late Mr. Laurie sowed alfalf about 1884; the season was dry, but the plants struggled on in spite of drought and gophers; the farm was subsequently abandoned, but in 1900, the alfalfa area was stil clearly defined and proved attractive to the cattle. Mr. Laurie was satisfied that thi would have done well, had he been able to care for it better. A man near Boscurvis has grown alfalfa for three years, and it has constantly improved. Near Prince Albert it was grown for five years by Mr. Acorn, but was then killed out by a late spring frost.'

In view of what I myself have seen in the North-west, and of statements made by farmers who have tried it upon small areas, I have thought it wise to recommend farmers in the West to test alfalfa more thoroughly, doing so on small areas and sowing in spring at the rate of from fifteen to twenty pounds to the acre, without any nurse crop and upon land which had been summer-fallowed the year before. The first year all that would be necessary, would be to mow the weeds. If, in districts where there is a little more moisture than is found on the open prairies, it was thought desirable to mix with the alfalfa or clover any grass, decidedly the best kinds for this purpose would be the Awnless Brome or the Western Rye-grass, which might be mixed in the pro- portion of ten pounds of alfalfa to six pounds of the grass seed. Awnless Brome does

not as a rule make a very heavy growth the first season, and therefore it would not crowd out the somewhat delicate alfalfa seedlings, nor deprive them of too much soil moisture. The alfalfa, being a very deep-rooted plant, would be well suited for cultivation with either of these grasses, the root systems of which are much nearer the surface. I am glad to learn that the North-west government has secured from the Russian government a quantity of seed of the Turkestan variety of alfalfa, which will probably be distributed for testing in various localities next spring. This variety is merely a form of the common alfalfa which has been grown in Western Asia for a long time and has thus become accustomed to more severe conditions. I was fortunate enough to secure from the United States Bureau of Plant Industry some seed of the original distribution which was brought to America, and have a vigorous plot now growing from that seed. The two plants are almost indistinguishable, although the Turkestan variety is rather more vigorous in growth; but the leaves and flowers of both forms are similar.

Collections.—The collections of insects and plants in the Division have been very much augmented during the past year, many interesting additions having been made from material collected in the field, as well as through the kindness of correspondents who have sent in collections to be named by the officers of the Division. The success of the recent Nature Study movement in education has had a marked effect in increasing the interest in the subjects dealt with in the Division of Entomology and Botany, as has been evidenced by the large number of natural history objects which have been sent in with inquiries for information concerning them. These were for the most part insects and plants and came from teachers, students and farm children living in every province of the Dominion. I was much pleased to have the opportunity of distributing useful knowledge concerning these important subjects in this direct way to those for whom it was of so much practical value; and, moreover, from this source many valuable additions have been made to all of our collections. For several years material of all kinds has been accumulating from my own collections in the West, from the extensive breeding investigations into the life-histories of insects which have been carried on here, and from specimens sent in by correspondents for examination. During the past season many insects have been mounted and arranged in the cases, as well as plants in the herbarium, so that we have in the Division fairly good working collections which are now available for reference when required.

Insects.—The chief effort has been made to study and represent in the cabinets the various stages of those species which are injurious to crops, and those which are known to be beneficial. Much has also been done to build up the general scientific collections of the different natural orders of insects.

Plants.—Large additions have been made to the collection of native wild plants, and some hundreds of sheets have been mounted and arranged in the herbarium. These consisted chiefly of plants of various orders from the North-west Territories, from the Rocky Mountains, and from British Columbia. A good representation has also been secured of fodder plants, particularly of grasses. Agricultural weeds and poisonous plants, which are a subject of burning interest in the wheat lands of the West, and on the stock ranges, are well represented in our collections, and a recent improvement has been made by arranging the collection of seeds of weeds and other plants; this collection now contains seeds of about 450 species and includes nearly all of the weeds of importance in different parts of the Dominion. These samples have been of much service in identifying seeds found among seed grain and clover and grass seeds, sent in by farmers and seed merchants for examination as to purity and for testing as to vitality.

Insects of the year.—I am pleased to report that there have been no serious outbreaks of injurious insects during the season of 1903, nor have any new pests of importance made their appearance. One species of interest, but of no great economic im-

portance is the Rhubarb Weevil (*Lixus concavus*, Say), which was found injuring rhubarb at Harrietsville, Ont. There was, however, been considerable loss in various parts of the Dominion from regularly occurring insect enemies; and, where farmers have applied promptly the remedies recommended, great saving has been effected. The season, on the whole, has not been quite as propitious as usual for good crops. Until the middle of June, the exceptional drought which prevailed through eastern Canada, prevented the germination of seed of all kinds, which retarded the development of many crops and exposed them to attacks from insect enemies. Later in the year, cool damp weather prevailed, which again delayed maturity and was the cause of some loss. Some of the leading features of insect presence during the year were the following:—

Among cereal crops there were no widespread or very serious losses. Hessian Fly was reported as the cause of some loss in Prince Edward Island, at one place in western Ontario and in restricted localities in Manitoba and the North-west Territories. The Wheat-stem Sawfly was abundant and destructive, although little observed, in south-western Manitoba. The Grain Aphis appeared suddenly during July and August in enormous numbers throughout Ontario, in Manitoba and in the North-west Territories and was the cause of considerable alarm; happily, however, the parasites which usually control this species, appeared soon afterwards and eventually, owing to the excellent weather for the grain to fill which prevailed last autumn, the injury was unimportant. In Manitoba locusts did some harm, but this was far less than in previous years. Farmers throughout the district, assisted by the provincial government, applied the standard remedy, the Criddle mixture, and in every instance with most satisfactory results. Experiments undertaken with a view to destroying these insects in a wholesale manner with the fungous disease which has been used in other parts of the world, were without avail, and this, I find, has been the general outcome of most experiments of this nature. Occasional successes which have been reported, seem to have been largely due to exceptionally advantageous atmospheric conditions at the time of the experiments. An outbreak which caused widespread alarm in Manitoba, was by the caterpillars of two broods of a common prairie moth, which this year appeared in vast numbers and, having consumed all of their natural food plant, the common weed known as Lamb's Quarters, ate many other plants, amongst which were some kinds of garden plants. This insect was the pyralid known as the Sugar-beet Web-worm (*Loxostege sticticalis*, Linn.).

Root crops and vegetables were diminished to a certain extent by the ordinary pests of the field and garden. Cutworms of various kinds were reported during the dry spring weather from all parts of the Dominion, and where not controlled did much damage. Root maggots, as usual, were irregular in their appearance, but in most places were the cause of great loss amongst onions, radishes, cabbages and turnips. The Colorado Potato Beetle was noticeably less abundant in most places. The Asparagus Beetle, a recent importation into Canada, although not a cause of much loss, has gradually extended its field of destructiveness, and last summer was reported as far east as Toronto.

Fruit crops generally have been good and remunerative, growers in all districts are seeing more and more the advantage of practising such common sense factors of success as spraying for the prevention of insect enemies and fungous diseases. The San Jose Scale has been held in check to a satisfactory extent wherever instructions of specialists have been followed, and although this insect has not spread beyond the limits of the previous year's infestation, the injury done and the future danger from its work are very great. The work of the Oyster-shell Bark-louse has been much complained of in New Brunswick, Nova Scotia and Ontario. The Pear-tree Flea-louse has been locally in Ontario the cause of considerable loss and has for the first time this year been recorded from Nova Scotia. The Pear-leaf Blister-mite is abundant in British Columbia and occurs now in every province of the Dominion. When trees have been sprayed just before the buds burst, with the lime, sulphur and salt wash, good results have followed. Plant-lice of various kinds were rather more abundant than

usual on apple, plum and cherry trees, but were in most cases destroyed by parasites before much damage was done. The Tent Caterpillars, Cankerworms and the Codling Moth were noticeably less troublesome last season than for some years.

Shade-tree and forest insects were seldom referred to in correspondence, and few serious attacks were observed. In Montreal, Kingston and Toronto the White-spotted Tussock Moth has increased so much that remedial measures are now urgently needed or the beauty of shade trees in these cities will be much marred at no distant date. A remarkable outbreak of the Maple Soft Scale, *Pulvinaria innumerabilis*, Rathvon, took place on the street shade-trees last summer in London, Ont., causing much inconvenience to foot passengers, and the same insect also occurred on the shade-trees in Woodstock, Hamilton, and some other towns in western Ontario. The Negundo Plant-louse disfigured shade-trees to some extent in Winnipeg, Regina and Calgary, but not to a very serious extent. An insect which has gradually increased in abundance and now is destructive over a wide area in Canada, is the Spruce Gall-louse represented in the East by *Chermes abietis*, L., and in the West by *Chermes sibirica*, Cholodk. On small ornamental trees, spraying with a tobacco and soap wash has been effective, but in forests nothing can be done to check the ravages. There are, however, indications in some places that good work is being done by parasites. The unsightly nests of the Fall Webworm have become conspicuously more abundant lately than they have been for several years, and already demand attention from municipal authorities in towns, as well as from fruit-growers in many parts of Ontario and Quebec, as also in British Columbia. The insect occurs right across the Dominion.

Live Stock.—The Cattle Horn Fly, which a few years ago caused such extensive losses to dairymen and stockmen in eastern Canada, has now reached the Pacific coast. Although still occurring in some numbers in the eastern provinces, its most severe attacks in 1903 were in British Columbia, where I found it last summer extremely abundant in some localities on Vancouver Island. Cattle-owners were not prepared to use the remedies which have proved to a large measure effective in the East; but, when these were applied, relief was soon apparent. The most convenient remedy in our experience, is to smear the animals on the parts most attacked with a light dressing of pine tar, one pound mixed with five pounds of lard or half a gallon of fish oil.* Specimens of the fly were sent from Regina by Mr. Willing, which he had taken on horses; but I saw no annoyance either to cattle or horses during a long journey through several of the cattle districts of the North-west in June and July last. I am hopeful that it is hardly likely this insect will ever be a very serious pest of stock in the dry regions of the West, where the cattle droppings, in which only the fly propagates while these are in a semi-fluid condition, dry up so quickly that they are soon unsuitable for the larvæ to live in.

Meetings.—Whenever official duties would permit of my absence, no opportunity has been lost of meeting farmers and of attending meetings of farmers' institutes and agricultural associations of various kinds. The subjects treated of at these meetings were as stated below:—

December 26 to 29, 1902: Washington, D.C.—Association of Economic Entomologists: 'Can the Pea Weevil be Exterminated?'; 'Injurious Insects of the Year in Canada.'

Through the kindness of the President of the Association, a special discussion was held on the former of these papers, and co-operation was promised by several of the entomologists at the United States experiment stations, in disseminating information and in applying remedies for the Pea Weevil in those States where pease are grown for seed.

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* This mixture contains twice as much pine tar as in former recommendations. We have found that it keeps off the flies much longer than the old mixture of 1 lb. in 10 lbs. of lard.

December 29, 1902: Washington, D.C.—Society for the Promotion of Agricultural Science: 'Co-operation in Fighting Insects.'

January 5, 1903.—A series of addresses on the Value of Nature Study in Schools was given at the school houses in the following places: January 5, Harmony, Cedardale and Oshawa. January 6, U. S. S. No. 4, Whitby; U. S. S. No. 5, Whitby and Kinsale. January 7, U. S. S. No. 1, Pickering; U. S. S. No. 4, East Pickering and Pickering Village. January 8, Pickering, Frenchman's Bay and Dunbarton. January 9, Audley, Brock Road and Cherrywood. January 10, a large meeting in the town hall at Whitby. At all of the above meetings I was accompanied by Mr. W. A. Dent, who delivered most interesting addresses upon the habits of birds. These meetings were organized to help the children of this district in competing for the prizes offered by the Live Stock Commissioner at the Whitby Model Fair.

February 18 : Toronto.—Canadian Association of Fairs and Exhibitions : 'The Value of School Children's Exhibits at Fairs.'

March 6 : Pembroke High School.—'The Value and Pleasure of Natural History Studies.'

March 16 : Toronto.—Canadian Institute : 'Rocky Mountain Plants and Insects.'

March 18 : Cowansville, Que.—(1) 'The Brome Corners Weed Exhibit and its Lessons'; (2) 'Fodder Plants Suitable to the Eastern Townships'; (3) 'Spraying to prevent Insect Injuries.'

March 21 : Toronto Teachers' Association.—'Nature Study, What is it ?'

April 3 : Renfrew.—'Why should boys and girls study Nature ?' A mass meeting held in the city hall. Renfrew Horticultural Society : 'What Everyone can do to Improve the town he lives in.'

May 11 : Hamilton Horticultural Society.—'Seasonable Hints on Insect Enemies.'

May 14 : St. Catharines district.—Examining orchards which had been treated with the McBain Carbolic Insecticide for the destruction of the San José Scale, in company with some members of the Ontario Fruit Growers' Association.

June 15 to August 21.—In the West, investigating an outbreak of locusts in Manitoba, and holding a series of farmers' meetings in the North-west Territories and in British Columbia.

September 3 and 4 : Ottawa.—Entomological Society of Ontario : 'Insects Injurious to Ontario Crops, 1903' ; (2) 'Entomological Record for 1903.' At this meeting a paper was also read by my assistant, Mr. Gibson, entitled 'Basswood, or Linden, Insects.'

September 16 : Whitby.—Attending the Central Ontario Model Fair and judging the natural history exhibits sent in by school children. Delivered an address in the evening at a public meeting upon 'The Children's Exhibits at the Fair.'

September 29 : Richmond.—Opening the Model Fair for Eastern Ontario. Address: 'Model Fairs and their Management.'

November 25 and 26: Leamington, Ont.—Ontario Fruit Growers' Association: (1) 'Insects Injurious to Fruit Trees and how to Fight them'; (2) 'Insects affecting House Plants.'

Correspondence.—The correspondence of the Division has been of the usual varied nature and as heretofore has taken up much of the time of the officers. Many of the letters written are practically articles upon special subjects which are suitable for publication in the press, and have frequently been made use of for this purpose, in that way reaching a larger number of interested readers than could be done by direct correspondence. From December 1, 1902, to December 1, 1903, the number of letters, exclusive of circulars, registered as received is 3,150, and the number despatched, 2,664.

Acknowledgments.—As in previous years, I take pleasure in gratefully acknowledging my obligation to many correspondents, to practical farmers who have much aided the work of the Division by promptly reporting outbreaks of injurious insects and

noxious weeds, and for making, at request, special observations upon these. I must particularly mention in this connection, Prof. John Macoun, of Ottawa, who has on many occasions helped me with the identification of specimens, and also Dr. L. O. Howard, the U.S. Entomologist, Dr. Harrison G. Dyar, of the U.S. National Museum, and Mr. B. T. Galloway, of Washington. My thanks are also specially due to Dr. J. B. Smith, of New Brunswick, N.J., who has examined and named for me large numbers of Noctuidæ taken in Canada.

In conclusion, I take pleasure in again testifying to the excellent work done by my assistants, Mr. J. A. Guignard, B.A., and Mr. Arthur Gibson, to whose loyal and careful work much of the success of the work of the Division is due.

I have the honour to be, sir,

Your obedient servant,

JAMES FLETCHER,

Entomologist and Botanist to the Dominion Experimental Farms.

DIVISION OF ENTOMOLOGY.

CEREALS.

Weather conditions during 1903 in all parts of the Dominion have been somewhat unusual, and crops of all kinds, particularly cereals, have suffered somewhat from this cause. Crop reports from the eastern provinces record a prolonged spring drought with frosts in some places, which in Prince Edward Island and Nova Scotia somewhat thinned fruit crops and retarded growth of hay and pastures. A noticeable absence of injurious insects, with the one exception of cutworms, is mentioned by numerous correspondents in the maritime provinces. In Manitoba, conditions at sowing time were exceptionally favourable and all crops were got in and started well. The weather up to the middle of May was somewhat cool, and there was not much growth of grass and no trees were in leaf. After that time copious rains fell, which germinated all seed and gave promise of an enormous crop. The dry June which followed, with only light showers in July, checked the growth somewhat and, in districts where there was too little rain, grain was prematurely ripened. The result was that crops were rather lighter than usual, and in some districts both in Manitoba and the North-west Territories, where rain fell late in the season, crops did not ripen early enough to escape injury. The handsome gross yield, however, of fifty-seven million bushels of wheat, with an average of over 18 bushels to the acre, in conjunction with the higher price of wheat, gave the farmers of Manitoba and the North-west good returns for their work. In British Columbia Mr. J. R. Anderson reports that all grain crops were good and free of injury by insects. In Ontario the growing of wheat has decreased considerably during the last two or three years. This is doubtless due to losses from the Hessian Fly. In 1900, 1,068,000 acres were put in to fall wheat and 377,000 to spring wheat, while in 1903 only 665,000 acres of fall wheat were sown, with 248,500 of spring wheat. Prof. James, in his November crop report, for Ontario, says: 'The yield of fall wheat per acre is large and the quality of the grain is, as a rule, first class. Taking both yield and quality into consideration, the crop of 1903 may be considered as one of the best in the history of the province. There has been a greatly increased area of wheat sown this fall, more particularly in the Lake Erie district and other localities where the Hessian Fly did so much injury during the previous three or four years. The crop of spring wheat may be counted as above the average, although not so good relatively as fall wheat.' Oats, in all parts of the Dominion, were a heavy crop, but in some places were late in maturing and rather light in weight. No injury by insects, either to this cereal or to barley, was mentioned, and only very few references were made to rust, notwithstanding the heavy rains in some districts. The season of 1903 was not very favourable for corn. Seed planted early did best; that which was put in at the ordinary time, germinated very poorly from lack of rain and was consequently late. The long open autumn, before severe frost came, gave an opportunity for the crop to mature well, and most of it was saved in good condition, both for the bin and the silo.

Pease, which for several years have suffered so severely from the Pea Weevil, were grown to a much smaller extent in Ontario than for many years. In 1903 there were 125,500 acres less land sown to this crop in Ontario than in 1902; but the crop reaped was 1,259,971 bushels above that of 1902, with an average of 22 bushels per acre, against 14½ the previous year. This improvement, it must be acknowledged, is to some extent due to the campaign against the Pea Weevil, organized by the officials of the Ontario Department of Agriculture and this Division. Many farmers and others who grew pease, demanded from their seedsmen seed pease which had been treated to destroy any

living weevils which might be contained in them, and the present satisfactory state of affairs emphasizes the importance of treating all seed before sowing it, and of insisting that all who sell pease should attend to this matter. If a little more effort is now put forth, I see no reason why the Pea Weevil should not be entirely wiped out in Ontario. The remedies which will, in my opinion, effect this, were given at length in my last report, and consist of sowing early, so as to hurry on maturity as soon as possible, reaping directly the crop is in a fit condition, threshing and fumigating with bisulphide of carbon at once and then bagging up the seed and keeping it in bags until required for use. If it is not considered convenient to fumigate the seed before sowing, all the weevils can be destroyed by sprinkling a little coal oil or turpentine over the seed and turning it well for two or three days before sowing, or the seed may be held over till the second year, when it will be quite free from weevils, because these always emerge at latest by the spring of the year following the season when they develop.

The GRAIN APHIS (*Nectarophora granaria*, Kirby=*Siphonophora avenæ*, Fab.).—The only insect which was complained of as having occurred in undue numbers on cereal crops during the past year was the well known Grain Aphis, or 'green fly.' There is no doubt that where this occurred early in the season some injury was done to growing wheat and oats, but for the most part, although the aphides were exceptionally abundant, the usual parasites accompanied them, and in a short time they entirely disappeared.

'Aweme, Man.—The Grain Aphis was extremely abundant on wheat and oats this year. They attracted our attention during the first week in July and later they were so plentiful that they wetted all the front part of the binder canvases, on which they could be gathered up in handfuls. Mr. Sutcliffe, of Treesbank, tells me that they were so abundant on his oats that they actually stopped the binder. On looking beneath the canvases, he found the rollers simply packed with smashed up plant-lice. These insects undoubtedly did considerable harm this year by sapping the vitality of the plants, thus preventing the heads from filling as well as they should have done. As usual, numerous parasites were present with these and the many other kinds of aphis which appeared on various plants this year. By the end of the season, the parasites had almost exterminated these.'—NORMAN CRIDDLE.

Samples and reports of the presence of the Grain Aphis were sent in from many places in Manitoba and eastern points in the North-west Territories, as well as from a few places much further west. It was reported as being unduly abundant in Manitoba, at Bagot, by Mr. Eli Roberts; at Portage la Prairie, by Mr. James Thompson, and at Miami, by Mr. Thos. Renwick, who spoke of it as general throughout that district. The farthest point west where injury was done was at Beaver Dale, N.W.T. (34.26.7 west of 2nd meridian), from which place specimens were sent by Mr. Geo. Fernie. At Ottawa large numbers of the Grain Aphis were found on wheat and oats at the end of July, and it was noticed in the experimental plots here that certain varieties of wheat were more attractive to the insect than others. As a general thing, the bearded varieties were found in this observation to be much less infested than bald wheats. In every instance, large numbers of parasites were found present with specimens sent in for examination. In our Ottawa fields these were represented by the following species of Hymenoptera: *Asaphes vulgaris*, Walk., *Lygocerus niger*, How., *Xystus* (Allotria) *tritici*, Fitch, *Aphidius avenæ*, Fitch, *Pachyneuron*, sp. There were also numerous specimens of the common coccinellids *Adalia bipunctata*, L., *Hippodamia convergens*, Guér., and the Thirteen-spotted Lady-bird Beetle (*Hippodamia 13-punctata*, L.), and of the Hovering Fly *Syrphus ribesii*, L.

Fig. 1.—Lady-bird Beetle: *a*, larva; *b*, pupa; *c*, perfect insect.

Fig. 2.—The 13-spotted Lady-bird Beetle—enlarged.

WHEAT-STEM SAWFLY *(Cephus pygmæus,* L.).—An insect which appears in a rather intermittent manner in Manitoba and the North-west Teritorries is the Wheat-stem Sawfly. Although present in considerable numbers in a locality one year, it seldom appears again in the same place the following year. It has from time to time been reported from Central Manitoba right across the plains to the Rocky Mountains. There are, I believe, other species of *Cephus* which attack various grasses in the West. In 1902, Mr. Norman Criddle sent me from Aweme, Man., a large number of stems of two grasses, *Ammophila longifolia* and *Agropyrum caninum,* which were attacked by Cyphid larvæ. Judging from the colour—one was bright yellow and the other white like the Wheat-stem Sawfly—there were at any rate two species ; but, unfortunately, I failed to rear any of the flies from the large amount of material sent me by Mr. Criddle. During the past season I received several infested wheat straws from Mr. John Davis, of Waskada, Man., who wrote :—

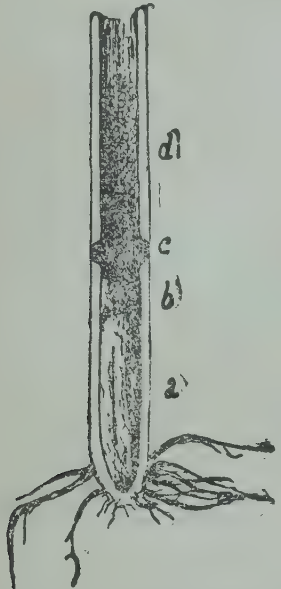

Fig. 3.—Wheat-stem Sawfly : *a*, cocoon, *b*, borings.

August 19.—I am sending you a few stems of wheat which I and many others here would like you to report upon. You will notice that some of the straws are broken or bent down three or four inches from the ground. The cavity of the straw is full of fine dust, and there is a small white grub about half an inch in length. This I have generally found low down quite near the root. It is very general through this district, but is not very destructive. The straws fall as they get dry, and where the attack is slight it might easily pass unnoticed. I have one field of 45 acres summer-fallowed last year. We were estimmating this to yield 30 bushels to the acre. There is about 5 per cent of this field down. I have not seen any other field so badly attacked as this is, but I have not seen any field about here that is quite clear of injury. It is a new pest here, and no one seems to know anything about it.'

This insect has provisionally been named *Cephus pygmæus,* L., and it certainly bears a close resemblance to that European species; but there are some points in its habits and life-history which do not agree, and it is just possible that the insect which occurs in our North-west may be a native grass-feeding species which occasionally attacks wheat when it finds that plant in a suitable condition at the time the females are laying their eggs. This can only be proved by carefully rearing a large series of the insects. The perfect insect is a shining black four-winged sawfly, banded and spotted with yellow, and having the abdomen slightly compressed. The head is large, with prominent eyes, the antennæ slightly club-shaped and composed of about 20 segments. The female is rather larger than the male and less ornamented with yellow. The average length of this fly is about one-third of an inch. The eggs are laid probably about the 1st of July, just before the wheat comes into head. They are inserted into the hollow of the stem by means of the female's saw-like ovipositor. The egg hatches in a few days, and the larva grows rapidly; before the straw ripens and hardens it will have eaten its way from the topmost joint of the stem to the lowest, feeding on the substance of the knots and on the inside tissues of the straw. About the time the grain ripens, it goes down to the lowest joint and gnaws away the inside of the straw so as to cut a ring almost, but not quite, through to the outside. This is just above or at the surface of the ground. The larva then burrows further down into the base of the stem and spins a very fragile skin-like cocoon, in which it remains unchanged until the following spring. The date of appearance of the perfect insect varies with the season and locality. I have taken specimens by sweeping, both in grain fields and on the prairie, from the last week of June to the middle of July. As all the larvæ pass the winter in the base of the straw, remedial measures must aim at treating the stubble

so as to destroy them or the pupæ before the flies emerge. I have suggested that this may be done either by ploughing deeply or by burning over the stubbles. As a few of the cocoons occur high enough up in the straw to be cut with the grain, all straw which cannot be used during the winter should be burnt.

The HESSIAN FLY (*Cecidomyia destructor*, Say).—This destructive insect, which a few years ago was the cause of such extensive loss in the fall wheat-growing districts of Ontario, was hardly noticed during the past season. Prof. Lochhead, of the Ontario Agricultural College, writes : 'This pest of wheat, barley and rye is no longer a serious enemy in the province. It has only been observed in one or two localities during the past season. In the vicinity of Georgetown it did much damage in wheat grown on stubble. A correspondent writes : "In good crops very little harm was done. On one occasion, in passing along the road, I noticed in a badly injured field that there was one very luxuriant patch of grain. I examined this patch, where evidently a pile of manure had lain, and found that the straw and grain were in good condition. I could not find a single stalk infested by the Hessian Fly." Most farmers are practising late sowing, that is about September 15. This probably had a good deal to do with the disappearance of the Fly.'

Fig. 4.—Hessian Fly : injured wheat-stem; 3 puparia—enlarged.

Reports from Prince Edward Island show that the Hessian Fly was noticeably present in several localities, and Mr. E. J. McMillan informs me that there was a considerable amount of loss in some places. In the West, Hessian Fly was mentioned quite frequently in correspondence from Manitoba and the Territories, but I believe that there was a confusion, in some instances at any rate, with the work of the Wheat-stem Sawfly. The only account of a serious outbreak was from Beulah, Man., where Mr. A. J. Dennis reports that 'the Hessian Fly has been much thicker this summer than I ever saw it.'

On the whole, however, there was probably not quite so much injury in Manitoba this year from Hessian Fly attack as in 1902. As has been frequently stated, there is normally only one annual brood of the Hessian Fly in Manitoba; consequently, the remedy is comparatively simple as compared with Ontario and the eastern provinces, where the insect is carried over in fall wheat. When Hessian Fly is known to be present in a district the grain should be cut high and the stubble burned over or ploughed down in autumn, and straw should be fed or burnt before the time the flies emerge the following spring. Screenings and rubbish from threshing machines should be put where poultry can get at them or where they will be trampled into the ground during the winter by stock.

LOCUSTS.

Locusts, or grasshoppers, which have been the cause of much anxiety in Manitoba during the past three years, again appeared last spring in the same localities as previously. They were so abundant that the provincial Minister of Agriculture again thought it wise to help farmers with advice and to supply Paris green for poisoning them with. Mr. Hugh McKellar, the energetic Chief Clerk of the Department of Agriculture, by instruction of his Minister, visited the infested districts and made arrangements for the distribution of poison. This was taken advantage of by many farmers, who used the Criddle Mixture with great satis-

Fig. 5.—The Rocky Mountain Locust.

faction. Some farmers who had read in the newspapers of experiments in treating grasshopper outbreaks with parasitic fungi, asked that some experiments of this nature might also be tried in Manitoba. The idea of treating outbreaks of injurious insects by means of introducing parasitic insects or fungi is an exceedingly attractive one, and, to those who have never studied these matters, is apparently a very easy solution of a difficult problem. Knowing that many of our leading American entomologists and botanists had made extensive experiments in this direction, but that nothing was being done by these students at the present time, I had not any very sanguine hopes of securing great success in Manitoba; but, as there certainly was a chance of doing good work for the province, I endeavoured to procure some cultures of the so-called South African Grasshopper Fungus for this purpose. After correspondence with many who had experimented, I at last succeeded, through the kindness of Dr. Howard, the United States Entomologist, in obtaining six tubes. These I took with me to Manitoba in June last and placed them in the hands of Mr. Norman Criddle, a careful experimenter and asked him to follow closely the instructions which accompanied them. This work was begun while I was with him and carried out by Mr. Criddle during the summer. Notwithstanding every care, this experiment must be recorded as a failure. I append herewith Mr. Criddle's report upon his work with locusts during the season of 1903.

LOCUST NOTES FROM AWEME, MAN., 1903.

By Norman Criddle.

There has been throughout this part of the country a marked decrease in the number of locusts during 1903, especially where they were poisoned last season. All the early damage done, which amounted to very little, was owing to many of the stubble fields being last spring devoid of all vegetation, and consequently locusts were obliged to attack the grain much earlier than they otherwise would have done. The first hoppers noticed hatched out on the 3rd May; they were becoming quite numerous by the 5th, and on the 12th the majority were out. They then began to do harm. By the 15th they had swept into some fields in millions, I think, thicker than I had ever seen them before. They had in three days marched 200 yards. Up to this time a small amount of damage was done; but this was principally owing to carelessness, and the insects were soon got under control with poison. By the 5th June most of the locusts had passed the third stage and, owing to the hot weather, it required a good deal of exertion to keep them from the growing grain. Wherever poison had been spread, countless numbers were found lying dead about the edges of the fields. At this period quite a number hatched in the wheat fields, the eggs having evidently been laid on summer-fallow last year. On June 13 most of the locusts were in the fifth stage, and the first one was noted with wings. By July 2 two-thirds could fly and some of them began migrating. By July 6 they could nearly all fly, and many of them flew into the crops. It is at this time that the second stage of the fight begins; the locusts, flying to all parts of the crop, eat the heads of grain. Fortunately, they soon collect into the sunny places, such as where the seeder has missed or any other open spot, so that, by walking up and down the fields, these places can be found and poison spread there. In fact, I am inclined to believe that in localities where locusts are troublesome it would be a good plan to miss a foot or so when drilling for the insects to collect upon. The migrating season was over by July 15, the weather at that time being cold and unfavourable for flying, so that very few left the neighbourhood. On August 1 the first female was noted laying eggs, although egg-laying did not become general until the 11th of that month, from which date eggs were deposited continuously until all these insects had disappeared. This they began to do about September 1, gradually getting less, until by October 3 they had nearly all disappeared. A few remained until the winter set in. The locusts responsible for damage this year were the same as last, and in the same proportion.

These were the Lesser Migratory Locust (*Melanoplus atlanis*, Riley), Packard's Locust (*M. Packardii*, Scudd.), the Two-lined Locust (*M. bivittatus*, Say), and the Rocky Mountain Locust (***M. spretus***, Uhler).

There is no doubt that the cause of the decrease in locusts was largely due to the co-operative work of farmers with Paris green, added to the increase of two species of Blister beetles, *Epicauta sericans*, Lec., and *Epicauta pennsylvanica*, DeG. This year the first of these insects were seen on June 1, and by the 4th of that month they had become abundant. *E. sericans* occurred on the dry prairies and *pennsylvanica* in somewhat damper spots, wherever the Wild Pea (*Lathyrus venosus*, Muhl.) is plentiful. *E. pennsylvanica* did considerable damage to potatoes and broad beans, but *E. sericans* is in no way injurious; it is, on the contrary, beneficial, as it seems to confine itself almost entirely to lamb's-quarters, though I have seen them actually eating wheat when other food was not to be found. The native food plant appears to be the Crocus Anemone, *Anemone Nuttalliana*, Gr., which I have often seen them eating. These beetles had all disappeared by August 28. That these two species of insects will be the cause of a still greater decrease of locusts next season is, I think, little to be doubted; for, although there are still numerous fertile eggs in some places, and notwithstanding that many locusts remained alive late into the season and there were an enormous number of eggs deposited, still, from observations I have made, I find that at least two-thirds of the eggs have been destroyed by Blister beetles. Of 141 pods examined, the eggs of 97 were destroyed. Of other locust parasites, there was an increase of tachina flies, and the Locust Mite seems to be rather more plentiful than usual. Another friend was Franklin's Gull, *Larus Franklinii*. During the migratory season, between July 26 and 31, thousands of these birds were to be seen flying up and down the fields, particularly on the summer-fallows, busily engaged in picking up locusts. Unfortunately, they were too late to prevent many of the females from laying eggs, although, of course, they did an immense amount of good.

Some damage was caused from locusts eating binder twine; very few had bluestoned the twine, and we have now been able to demonstrate without a doubt that some brands of binder twine are much more subject to attack than others. Whether it is that certain brands are made of different material or that they are looser than others, I cannot say; but the twine which was most attacked is very loosely twisted.

With regard to what you have called the Criddle Mixture, numerous tests were made with Paris green during the season to ascertain as accurately as possible the strength required to kill locusts, and it was found that one pound of Paris green could be mixed with five patent pails of horse droppings with absolute success. Weaker mixtures were not quite so successful. In the past, I believe a large amount of Paris green, as well as labour, has been wasted through putting out the mixture in cold or wet weather, whereas I find that practically no feeding takes place in the spring with a temperature below 50°F. It is on the hottest days that locusts eat most, and consequently are most easily poisoned. In the early stages locusts much prefer the mixture moist, and I have found that spreading a little every other day, in the morning, gives much better results than scattering a lot at a time, and less frequently. Another advantage of spreading lightly is that the danger of cattle eating it is greatly lessened, whereas when put in lumps the danger is claimed to be considerable.

I regret to say that some cases of cattle poisoning were brought to my notice during the season. Though in every case the loss was the result of either ignorance or gross carelessness, in some cases, through spreading the mixture in too large lumps, or even putting it in pasture fields, or through leaving the barrel or whatever it was mixed in, where cattle could get at it. As I have said more than once, if the mixture is only scattered properly, there will be practically no danger. A good preventive measure is to keep cattle well salted. As Mr. McKellar remarked, 'Some farmers are overgenerous with salting their grasshopers, but neglect their cattle. This is a fact.

Locust fungus.—I am sorry to say that the tubes of the fungous locust disease left in my care, proved a complete failure. One failed to show any signs of growth, but

the others were perfectly fertile. The first culture was mixed in sugar and water and was left in a warm place, as directed, until it showed signs of growth, when it was put out as follows: (1) Scattered among the grass infested by locusts; (2) locusts were caught and dipped in it; (3) it was put on pieces of horse droppings, bran and other attractive food, the weather at the time being very dry. Locusts after being dipped in the culture were kept in a large box for some days, but showed no signs of being any the worse for their treatment. The second culture was put out on the evening of July 22, during damp and rainy weather, though rather cold. It was spread among the locusts in the same way as the first. Two locusts were found dead, possibly as a result of this, three days after it had been put out.

The third lot of fungus was put out on July 15, in the evening when considerable dew had fallen. No results were observed. Another lot was put out on the 16th. This was mixed in bread crumbs, some of which was eaten by locusts; but no dead insects were found. During the time several locusts were found which had been killed by the native fungous disease in spots widely removed from one another and at long distances from where the experiments were being conducted, showing that the weather conditions were at least fairly favourable for this work, and also that this disease is probably always present and makes its appearance as soon as the conditions are favourable. The last lot of fungus was put out on August 2 in the same way as the first. No results were noticed.—NORMAN CRIDDLE.

Referring to the above statement that cattle have been poisoned by the Criddle mixture, it need hardly be pointed out that, with this remedy as with every other in which an active poison is used, at any rate ordinary and reasonable precautions must be taken to prevent stock of all kinds from eating the material. It is well known that horned stock will, if allowed to do so, eat the bedding from a horse stable, but this can hardly be recommended as a good food for the production of milk, and the practice should be prevented. If the Criddle mixture is distributed in the manner recommended, that is, for the material to be scattered loosely through the plants at the edge of a field of standing grain, it can hardly be said that there is any danger. One instance came to my knowledge of a man in Manitoba who had mixed half a barrel of the Criddle mixture, part of which he did not use. The half barrel containing this was put in his barn and left there till threshing time, when, to make room, it was turned out into his yard where he had some cows. Some of these ate the poisoned material and died from its effects, but this instance of carelessness can hardly be cited as a reason for not using this most useful remedy against grasshoppers. If it is, it means that the use of active poisons such as Paris green and many other compounds now thought to be necessary to the fruit-grower and farmer, and the whole operation of spraying, would have to be condemned. On occasions when farmers have been using the Criddle mixture, which is in every way the cheapest effective remedy for grasshoppers which I have ever tried, if there is any of the material left over, it should be scattered loosely over a piece of land where its fertilizing effects may be secured and where there will be no danger of poisoning animals.

The only other place in Canada where grasshoppers were noticed in numbers was in the Okanagan valley of British Columbia. Mr. E. P. Venables, of Vernon, writes: 'Grasshoppers were numerous at some places, and, although no appreciable damage was done, some people are anxious lest there may be a repetition of the plague of three years ago. Some of their enemies, however, were in evidence to an equal extent with the grasshoppers. Among these, the Spotted Gray Blister-beetle (*Epicauta maculata*, Say) was very abundant, feeding upon wild plants. Therefore, it is to be hoped that their larvæ will help, if they keep up their good name for destroying the eggs of grasshoppers.'

The Criddle mixture, as modified in accordance with the latest experiments, consists of one part of Paris green, mixed thoroughly in 100 of fresh horse droppings, to which two pounds of salt per half barrel of mixture have been added, after being dis-

solved in water. This is placed in a half barrel and drawn on a cart to the edge of an infested field or one likely to be infested. The mixture is then scattered broadcast along the edge of the crop by means of a trowel or wooden paddle. The locusts are attracted to it from long distances and are killed in large numbers by eating the poison.

FIELD CROPS.

The Clover Seed-midge (*Cecidomyia leguminicola,* Lintner) has been the cause of very serious loss to seed growers in all parts of Ontario where clover seed is produced. Probably one-half of the crop was destroyed by this insect. In some districts the whole crop was completely ruined. The remedy of feeding off or mowing the first crop of clover before June 20 has been found satisfactory by all who have tried it. The reason of this is that the maggots of the first brood come to maturity towards the end of June, and then leave the clover heads to enter the ground, where they complete their changes; and if the clover is cut or fed off before that date, the immature larvæ are destroyed. If the clover is left standing later than June 20, the maggots will have time to complete their growth and leave the clover heads. From these larvæ the second brood which attacks the seed of the second crop is produced. Just about the time the seed is ripe, the larvæ of the second brood fall to the ground and burrow beneath the surface, where they pass the winter, the flies emerging in June of the following year and laying their eggs in the flower heads soon after these form.

The Hop Aphis (*Phorodon humuli,* Schrank).—It is many years since serious complaint has been received at the Division of excessive injury by the Hop Aphis. In the extensive hop fields of British Columbia there is an occasional outbreak, but the excellent crops of the last few years and the high price which has been secured for British Columbian hops, shows that this crop has been produced to great perfection and without serious injury from insects. In some of the plantations in the valley of the Fraser it has required constant attention on the part of growers to keep the 'Red Spider' under control; but this has been done to a reasonable extent. The sovereign remedy for all mites, of which the so-called Red Spider is one, is sulphur in some form, either as flowers of sulphur mixed in the ordinary quassia and tobacco wash, which is pretty generally used as a remedy or a preventive of Hop Aphis, or distributed as powder through the plants. A new pest which has appeared in sufficient numbers this year to be noticed in British Columbia is *Psylliodes punctulata,* Mels., a small flea-beetle which was sent in by Mr. H. Hulbert, of Sardis, B.C., under the name of the Hop Flea-beetle. This has been referred to briefly as a hop pest in Bulletin No. 4, old series, of the United States Division of Entomology.

Some years ago hops were grown to a large extent in Prince Edward County, Ontario ; but of late years the industry has been to some measure given up for the cultivation of other crops. Some growers, however, have continued to grow hops, and quite recently others were resuming the practice. During the summer of 1903, which, as has been stated already, was particularly characterized by the abundance of many kinds of plant-lice, the hop yards of Ontario have suffered from a serious visitation of the old-time enemy, the Hop Aphis. Through the kindness of Mr. John D. Evans, of Trenton, I have received a great deal of information concerning this outbreak, and he has been good enough to visit and interview several of the growers who were most interested in this subject. I have also received from Mr. W. B. Cooper, of Bloomfield, Ont., who has been for many years an extensive grower of hops, a detailed account of this outbreak. Mr. Evans writes:

'Trenton, Nov. 23.—Mr. H. S. Miller, of Picton, who is a large dealer in hops, and who visited many of the hop yards at different times during the past season, states that the total hop crop in the district this year yielded only 46 tons; last year, with

the same acreage, it was 128 or 130 tons, and that at least two-thirds of the hop acreage this year was afflicted with the pest. Although the loss was severe in some places, it was not general throughout the district; for instance, Mr. Branscombe, of Chisholm, only got two bales from three acres, his crop being almost a total failure. He stated that the insects appeared first of all as plant-lice when the hops were coming into burr. After that it seemed as if a blight had struck them; the vines which were affected produced no hops, and the leaves turned black. On a knoll in his yard the vines were heavy and produced the two bales referred to. Then, on the other hand, Mr. Philip Vanmeer, of Bethel, Ont., had 22 acres of hops. The centre of his yard was on high ground, but the land sloped off in all directions to low ground. His yard was not affected, and he did nothing in the way of spraying or otherwise, in the way of special treatment, except that the yard was kept thoroughly cultivated. He had a very heavy crop. It would appear, then, that the abundance of this insect is not affected by the land being high or low. A great many ladybird beetles were present among the aphides. There was a similar visitation by the Hop Aphis in 1886, when the hop crop was almost ruined; but since that time the insect has occurred only in very limited numbers and has not been noticed. None, or very few, of the growers here have done any spraying, as they have not the special apparatus which is necessary. I am told that the spraying pumps which answer for fruit trees will not for hops.'

Mr. Henry Corby, of Belleville, Ont., as far as I can learn, was the only grower who sprayed his yards in a thorough way to protect them from injury by the Hop Aphis last year. His experience, however, has been so widely commented upon by hop growers in the vicinity and in Prince Edward county that I have no doubt the wise measures adopted by Mr. Corby will have the good effect of inducing others to spray their yards next year, should there be any appearance of the Hop Aphis. Mr. Corby writes:

'Belleville, Nov. 19.—Your favour in *re* Hop Plant-louse received. In reply we first noticed the Hop Plant-louse on the vines about the 1st July. From the 1st to the 10th they came on very thickly indeed. As I had eighty acres under cultivation, we continued the spraying for close on to a month. The mixture I used, was 7 pounds of whale-oil soap and 8 pounds of quassia chips, boiled for an hour. This made 100 gallons of wash. I used an English sprayer which takes two horses to draw it, but it does thorough work. I consider that I lost one-quarter of my crop at least; but, had I not used the sprayer, I doubt if I should have had any hops at all. The quality of my hops is first-class.'

The life history of the Hop Aphis is a remarkable one and is given in a condensed form in my annual report for 1889, which I repeat herewith, as the life history has an important application in this species, to the remedies which are suggested. The life history of the Hop Aphis has been carefully worked out by Prof. Riley and recorded in his report for 1888 as follows: 'Of this species the winter eggs are laid by the perfect females upon plum trees in autumn. From these hatch, the following spring, wingless females which are called "stem-mothers." These produce young plant-lice by a process analagous to budding in plants and known as parthenogenesis (from the Greek *parthenos,* a virgin, and *genesis,* production), which means the production of young from imperfect and unimpregnated females, without the intervention of a male. There are three broods of these parthenogenetic females produced on various kinds of plum trees, the third becoming winged. This last is known as a migrant and it instinctively flies to the hop plant, which up to this time has been free from attack. A number of generations of wingless females are produced upon the hop until, in autumn, winged females known as the return migrants again apear. These return to the plum and produce some three or more young which have no wings but are true sexual females. Somewhat later than this, upon the hop vines true winged males, the only males of the whole series, are developed. These fly to the plum trees and towards the end of the season may be found pairing with the wingless females, which afterwards stock the tree with eggs which pass the winter there.'

The above life history will show how complex and difficult to understand are the habits of some of our injurious insects. The importance of this knowledge, however, cannot be over-estimated; for it is plain that, if the Hop Plant-louse passes the winter in the egg form upon plum trees, by having no plum trees near the hop yard, the opportunities for the insect to increase in a certain district are much reduced, and, further, that, if plum trees near hop yards are treated during the winter to destroy the eggs, a very large proportion of the infestation can be wiped out. It has frequently been noticed by farmers and others with what enormous rapidity the different kinds of plant-lice sometimes increase. Dr. Wm. Saunders, in the annual report of the Entomological Society of Ontario for 1878, refers to this matter as follows:—

'Some idea may be formed of the numbers to which in a short time plant-lice increase, from a calculation of Curtis, the celebrated English entomologist, who computed that from one egg only there would be produced in seven generations, taking thirty as the average of each brood, the enormous number of 729,000,000, so that, were they all permitted to live, everything on the face of the earth would in a short time be covered with them. Indeed, sometimes the possible rate of increase is even greater than this. Dr. Fitch, the state entomologist of New York, ascertained by actual experiment, that the wingless females of the Grain Aphis became mothers at three days old, and thereafter produced four young ones every day, so that even in the short space of twenty days the progeny of one specimen, if all were preserved from destruction, would number upwards of two millions.'

Some of the useful facts derived from a knowledge of the life history of the Hop Aphis, are that, as the eggs are laid upon plum trees and pass the winter there, it is important not to allow wild or useless cultivated plums to grow round hop yards; but, if these trees are growing in the vicinity and it is impracticable to destroy them, the value of treating these before the eggs hatch, or just at the time the young plant-lice are hatching in May, with kerosene emulsion, or a whale-oil soap solution, is manifest. As the males are only produced at one season of the year and this on the hop plants after the females have migrated to plum trees, the utility is plainly shown of burning up at once after the crop is picked all the vines and leaves of the hop plants. In this way, it is believed that so many of the males will be destroyed that there will not be enough left to fertilize all the females which have flown away to the plum trees. Although plant-lice can produce young for a long time without the intervention of males, when the time comes for the perfectly sexed females to be produced, the males are necessary for the fertilization of the over-wintering eggs.

As there are three broods produced upon plum trees subsequent to the hatching of the eggs, it is not until comparatively late in the season that the plant-lice appear upon the hop vines. It is an important observation then to know exactly at what date this migration from the plum trees to the hops takes place, because these insects are exceptionally prolific and multiply with enormous rapidity as soon as they reach the hops. Consequently the sooner the plants are sprayed to destroy the aphides the easier that work will be accomplished and naturally at a much smaller loss of vitality to the plants. In New York State the migration from the plum trees to the hops takes place in the month of May, so it is probable that this may also be expected about the end of that month, or early in June, in southern Ontario.

As to the best insecticide for controlling the Hop Aphis, there are several which may be used. Kerosene emulsion diluted to as weak a wash as one part to twenty-five of soft water, will kill the insects upon the foliage at the time they migrate to the hop plants. This strength will not injure the leaves, which it is stated is the case with stronger mixtures. To destroy the winter eggs on plum trees a much stronger mixture of the emulsion, viz., one to six, is necessary. Instead of the above, whale-oil soap, one pound to six gallons of water, may be used on the hop vines. The remedy, however, which is by far most generally used by hop growers in England, California and British Columbia, is the one which has been styled the 'English wash,' and is the stan-

dard remedy for the Hop Aphis in the hop gardens of the south of England. It is very similar to the one used by Mr. Corby, mentioned above :

100 gallons of soft water (if the water is hard add soda).

4 to 5 lbs. of soft soap.

6 to 8 lbs. of quassia chips, first steeped in cold water and afterwards boiled for one hour before mixing with the main supply of water.

The value of this wash has been clearly shown in England, where some hop-growers, as is the case with ourselves, do good careful work and get large and paying crops of hops of the first quality, while others who do not attend to these important matters get nothing at all or very little. The points most to be borne in mind by hop growers in this conection are,—that early work is less troublesome, less expensive, and pays enormously all trouble taken, therefore constant attention must be given to the yards at the time the insects migrate to them, and lastly, that one application of any remedy is not sufficient. The washes effective against plant lice, unlike the arsenical poisons which are placed on foliage and remain active for a long time until eaten by insects, are contact remedies only which, to be of any use, must actually be thrown on to each individual insect ; moreover, as the plant-lice do not all migrate to the hops at the same time, two or three applications at short intervals may be necessary. Throughout the summer the various broods of the hop aphis are wingless, therefore, if the first broods which appear on the hops are thoroughly dealt with, the yards can be kept clear for the rest of the season.

ROOTS AND VEGETABLES

Roots crops in all the eastern provinces of the Dominion have suffered from the unusual weather which prevailed generally last spring from the lakes to the Atlantic coast. The dry late spring prevented prompt germination of seed when sown early. Mangels were not up to average, from poor germination and the attacks of cutworms. Sugar beets, which are now being grown in many parts of Canada both for sugar and for stock, gave a fair crop. Turnips, where not injured by cutworms and the Turnip Aphis, gave good returns, particularly from late sowings put in after the June rains. Potatoes did not start well, owing to the drought of May and early June. The crop, however, was fairly good in size and quality, where not injured by the 'Potato Rot.' This disease, which can to such a large extent be prevented by spraying with Bordeaux mixture, as has frequently been pointed out in these reports, was, it is to be regretted, very destructive from the Maritime Provinces to the Prairies. The following extracts from Mr. B. W. Chipman's Nova Scotia government crop report for November last, are well worthy of consideration by the thousands of farmers and others who grow potatoes either in large or small quantities :—

'Chester.—The potato crop will be heavy and of large size, but the rot has begun in some places very badly. Early spraying with Bordeaux mixture has proved beyond doubt a preventive for blight rot, and should be thoroughly tested by all potato growers. The trial costs little and the result in this district has proved its value. Spray as soon as the plant is in blossom, and twice at intervals of two weeks later on, if the season is wet.'

'New Germany.—No potato bugs. Potatoes took blight about September 1, and in some cases 50 per cent are rotten. One man here, and only one, as far as I know, sprayed his potatoes, with the result that less than 1 per cent were rotten.'

The results of demonstration experiments which have been carried on at the Central Experimental Farm, Ottawa, year after year, for many years, have uniformly shown the enormous benefit of spraying potato vines about August 1, and twice afterwards at intervals of 15 days, with the Bordeaux mixture, which for this purpose con-

tains bluestone, 6 lbs.; unslaked lime, 4 lbs.; Paris green (to destroy leaf eating insects) 4 ozs., and soft water 40 gallons.

In the Ontario crop report for November last, Prof. James refers to the prevalence of the potato rot and estimates the loss at from 10 to 60 per cent in various localities. Mangels were in some places replaced by turnips, where the seeds had not germinated well, and turnips, although yielding a good crop, were in many quarters considerably injured by the Turnip Aphis.

The Colorado Potato Beetle was reported from all sections as being less abundant than for many years. The following reports are representative of many others received:—

'Charlottetown, P.E.I.—Root crops were badly injured by cutworms, and many fields were resown for the third time; some land was ploughed up and sown to other crops. The yield of roots was fair on the decreased acreage; the cutworms seem to have been general over the whole province.'—E. J. McMillan.

'Halifax, N.S.—Roots and vegetables good; potatoes above the average. No complaint of injurious insects on potatoes except the potato bug, and that was not as bad as usual. In some places, mangels, beans and vegetables were injured by cutworms. Turnips were somewhat attacked by aphis.'—B. W. Chipman.

There were not many large fields of roots this year in the province of Quebec. Many thought that it was too late after the rain came to bother with roots, so on the whole there will not be a very large crop. Some few have fair pieces.'—Peter Macfarlane.

Root Maggots.—Among vegetables, considerable injury has been done in nearly all parts of the Dominion by root maggots. The Cabbage or Radish Maggot, and the Onion Maggot, which for all practical purposes may be treated of as the same species, caused great loss in crops of cauliflowers, early cabbages, turnips, radishes and onions. The occurrence, however, was irregular, much harm being done in spots, while in another not very far distant there was no appearance of the attack. There is nothing new so far in the shape of a remedy for these insects when large areas have to be treated; but some experiments which have been carried on by the Horticulturist at the Central Experimental Farm during the past summer with the object of producing early tobacco and vegetables of high quality, have an important entomological bearing which is well worthy of mention. An enclosure was made of a light framework of wood, six feet in height, and covered entirely on the top and along the sides with cheese cloth. In this tent tobacco and various kinds of vegetables were sown, or planted, and a similar duplicate plot was also planted just outside with the same conditions of soil and soil moisture. The rows of this plot were practically in continuation of those inside the enclosure. This experiment was satisfactory, both as to forcing the plants forward to earlier maturity, and on account of the important discovery made by Mr. Macoun that this cheap protection prevented entirely the attacks of many kinds of injurious insects. Radishes, onions, cabbages and cauliflowers developed well and were absolutely free from root maggots. Nothing was attacked by the troublesome Tarnished Plant Bug (*Lygus pratensis*, L.) or the Four-lined Leaf Bug (*Pœcilocapsus lineatus*, Fab.). Cucurbits of all kinds were entirely free from injury by the Striped Cucumber Beetle. In fact, this experiment has furnished us with a sure means of growing many vegetables of which, from the difficulty of getting them into perfect condition, gardeners had in some places given up the cultivation. This is particularly the case with cauliflowers, early cabbage, radishes, onions

Fig. 6.—Cabbage Maggot: 1-3, maggot and pupa case; 4, fly—1, 3 and 4 enlarged.

and other plants of only moderate height. These could be entirely protected by a framework which any ordinary workman could make, only three feet high and three feet wide for single rows in a garden. With such a covering, it would be impossible to cultivate between the rows; but, if made in sections, these could be removed for that purpose when necessary. The cost of building an inclosure in which a man could work with ease and where several hundreds of plants could be grown, would be little compared with the increased price which would be obtainable for the earlier and much superior crop. Careful handling in taking down and storing away the cheese cloth and framework would insure the lasting of these for at least two or three years. These inclosures are manifestly better suited for the cultivation of some plants than for others; such plants as egg plants and cucurbits, which depend on the intervention of insects for the fertilization of their flowers, would require to be fertilized by hand if grown in these inclosures. A noteworthy result of these experiments was that the vegetables grown within the inclosure were entirely free from attacks of root maggots, while those grown in the corresponding plot outside were badly affected.

Remedies for root maggots are frequently asked for, and those which have been recommended in the past are as follows : For early cabbage and cauliflowers, the best remedy is undoubtedly an early application of the disks of tarred paper recommended by Prof. Slingerland. We use these regularly at the Central Experimental Farm, and always with great satisfaction. Where these have not been put on early, a remedy which may be used is to pour about half a teacupful of a strong decoction of pyrethrum insect powder, four ounces to the gallon of water, around the roots of each plant, after drawing away the earth right down to the rootlets. The earth must then be pushed back again. For onions and radishes, dusting white hellebore along the rows as soon as the young plants appear, has given good results in seasons when the flies are not abnormally abundant. Kerosene emulsion and a solution of whale-oil soap have also been used by some. Another excellent remedy is the carbolic wash recommended by Prof. A. J. Cook many years ago. This consists of boiling up one quart of soft soap, or one pound of hard soap in a gallon of water. When boiling, add half a pint of crude carbolic acid. Boil for a few minutes and stir thoroughly. The mixture is then ready to be stored away for future use. When required, take one part of this mixture by measure to fifty of water, and sprinkle or spray directly upon the growing plants once a week from the time they appear above the ground.

The Cabbage and Turnip Aphis *(Aphis brassicæ, L.)*.—Although not so injurious as it has been in some previous years, this insect was the cause of considerable loss in British Columbia, Ontario, Nova Scotia and Prince Edward Island. The worst attacks were probably in Prince Edward Island and Nova Scotia, whence frequent requests for information came. The injuries were to both cabbages and turnips. When cabbages in gardens are attacked, the insect should be looked for when the plants are being cultivated, and, as soon as the first colonies appear, which will probably be late in July or in August, they should be attended to at once, before they increase in numbers. Whale-oil soap, one pound in six gallons of water, or the ordinary 1 to 9 dilution of kerosene emulsion, if sprayed thoroughly, will destroy the aphis. In turnip fields, where by far the greatest amount of injury is done, those engaged in thinning and hoeing should be constantly on the watch for infested plants, which may at that time be hoed out and destroyed. This will, in many instances, be sufficient to prevent the occurrence later of a serious outbreak. The eggs of this insect are laid on the turnip tops late in autumn. This suggests the

Fig. 7.—The Cabbage Aphis : 1 and 2, male; 3 and 4, wingless female—2 and 4 enlarged.

advisability of ploughing down deeply all tops which are cut from the roots at the time of harvesting in autumn, so as to destroy the eggs. In fields of cabbages, where also eggs are laid, the same practice should prevail when the cabbages cannot be fed or are too poor to store for feed purposes. The leaving of poor or imperfectly developed crops in the field until the following spring is always a dangerous practice from the point of view of those who study insect attacks. Not only may the crop have been reduced to its worthless condition by the attacks of insects which will pass the winter safely among the plants; but, even on well developed plants, there are always certain natural enemies the presence of which is detrimental to the farmer and gardener. Whenever possible, all haulms, vines, stems and foliage should be fed to stock; but, in the few cases where these are useless, they should be ploughed down into the soil to decay or be burnt, and, when this can be done in autumn, it is far better than waiting till the following spring. Many insects and fungous diseases are thus destroyed or placed where they can do no harm, and much time is saved in spring in having the land in a condition to start work at once.

CUTWORMS.—These troublesome caterpillars have, as is usually the case, been more or less destructive to field and garden crops everywhere; but in Nova Scotia and Prince Edward Island almost every report mentions their depredations, and the official crop reports from these provinces show that considerable harm was done in almost every county. Such specimens as were received at the Division were the Red-backed Cutworm *(Paragrotis ochrogaster,* Gn.). The same species was the one responsible for most of the harm done in Quebec, Ontario and Manitoba. In Ontario it was accompanied by the Dark-sided Cutworm *(Paragrotis messoria,* Harr.), which was enormously abundant in some places at Ottawa. Here also in restricted localities the so-called Climbing Cutworm *(Paragrotis scandens,* Riley) was troublesome in sandy fields. At Regina and Calgary, N.W.T., the species which did harm in gardens was *Chorizagrotis auxiliaris,* Grt., the large caterpillars of which resemble the Red-backed Cutworm in a general way, and are equally omnivorous, destroying all kinds of succulent plants. The moths of *C. auxiliaris,* Grt., as well as of the allied *C. introferens,* Grt., and *C. agrestis,* Grt., both of which, possibly, are only varieties of *C. auxiliaris,* Grt., have been taken in large numbers at Millarville, 20 miles south of Calgary, by Mr. F. H. Wolley-Dod, and by Mr. T. N. Willing, at various places north and south of Regina. In Vancouver Island the species which was most troublesome proved to be *Paragrotis perexcellens,* Grt., which was very much commoner than it had been for some years. In 1885 it was a perfect plague in market gardens around Victoria, and in 1888 specimens were also sent to me, which were at that time incorrectly identified and mentioned in my report for 1888 as an allied species, under the name of *Agrotis obeliscoides,* Gn.

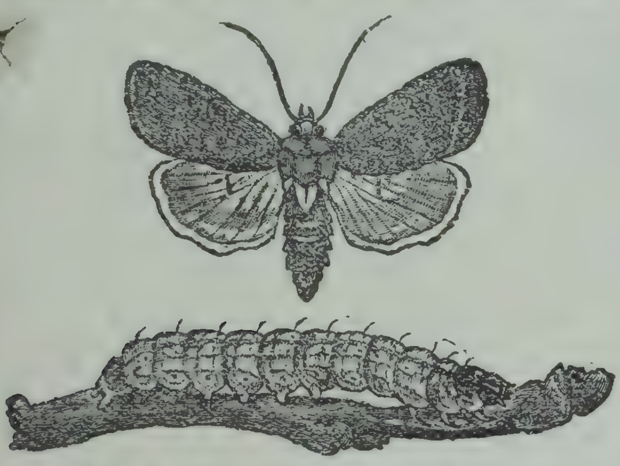

Fig. 8.—The Climbing Cutworm: moth and caterpillar.

All of the species mentioned above have the same feeding habits and would be controlled by the same measures, which are: The removal from gardens or fields, as early as possible in the autumn after crops are reaped of all refuse, and the cultivation of the land so as to prevent the deposition of eggs. This takes place during August and September, and some of the eggs, if not all of them, remain unhatched until the following spring; therefore, late fall ploughing, or early spring ploughing, by which the eggs were buried deeply would be beneficial. When in large numbers, these caterpillars, like most other cutworms, wander long distances at night in search of food. Therefore, it is necessary to make some direct application

to destroy them. For this purpose, the best remedy in my experience is the poisoned bran mash, which is remarkably efficacious. In making this material, which is equally useful in field practice as in gardens, it is best to dampen some of the bran slightly with water containing a little sugar. After mixing thoroughly, add the Paris green little by little, stirring all the time. If Paris green is added to the bran when it is perfectly dry, it will, owing to its weight, sink at once to the bottom when stirred. Half a pound of Paris green is sufficient to poison 50 lbs. of bran, although double this amount may be used. Bran should be added to the mixture until it will crumble easily and run through the fingers without adhering. It may then be distributed through or along the edge of an infested crop or may be applied to land either around or between plants, or a row may be run close to drills by means of a Planet Jr. seeder, or a similar implement. For such crops as tomatoes, cabbages, tobacco, &c., a collar of paper put around the stem at the time of planting, will prevent the destruction of many plants. Seedlings must be planted so that none of the leaves hang down and touch the ground. The same protection is provided in a more permanent manner, but at greater cost, with strips of tin. Convenient rings may be made from old tomato and fruit cans by throwing these into a bonfire and melting off the tops and bottoms and then splitting the sheet of tin which is left down the centre. This not only makes a good protection against cutworms, but disposes of a class of rubbish which often accumulates to an inconvenient degree.

The SUGAR-BEET WEBWORM *(Loxostege sticticalis, L.)*.—When in Manitoba last July, my attention was drawn by Mr. Hugh McKellar to reports which appeared in the newspapers of swarms of a small blackish caterpillar which had appeared at Brandon, and other points east and west of that city, and which after devouring its natural food plants, had wandered in armies to new fields in search of food. The first notice of this insect in 1903, came to me from Mr. J. R. McMullen, of Melita, Man., who stated that two years before this he had noticed enormous numbers of small moths among his wheat in the month of June. He writes on June 15, in a letter addressed to the Department of Agriculture for Manitoba, which was referred to me, an interesting account of an excessive occurrence of the caterpillars during 1902, as follows: 'I thought no more of these moths until last summer. I had ploughed a field of stubble in June and sowed it in Brome grass, of which I got a good catch. There was a lot of pigweed in it, and, when the weeds were about four or five inches high, I was surprised to see thousands, yes millions of worms, eating up the pigweed, making a complete job and killing it entirely. On thirty acres they ate every pigweed, but very little of the grass or any other plants. They started to work on the north side of the field and travelled south. Nothing would turn them. When they came to the tub where the horses are watered, they crawled up the sides and fell into the water by thousands; even when they came to the house, they crawled up the walls and clean over the house. These caterpillars were from three-quarters of an inch to an inch long, greenish in colour and with yellow stripes down the back and sides for the full length of their bodies. On the back the stripes were widened out or dotted in ten or a dozen places. When they reached the garden, they ate nothing except beets, although they tasted some other vegetables but did not eat much of them. They came to a big field of wheat just headed out, but did it no harm. In four or five days they were all

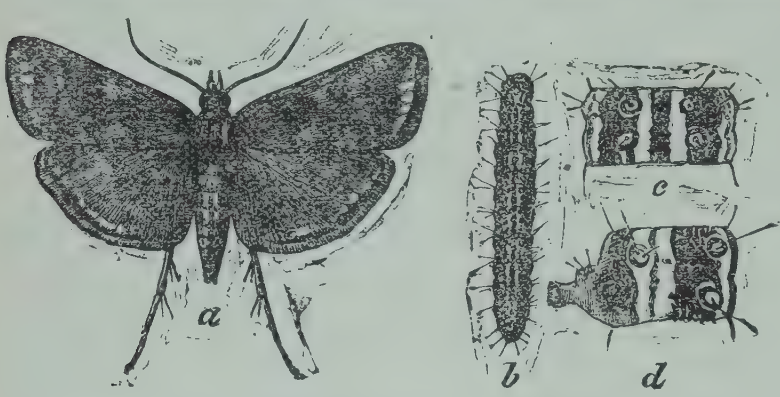

Fig. 9.—The Sugar-beet Webworm: *a*, moth; *b*, caterpillar; *c*, *d*, segment of *b*—all enlarged.
(Chittenden, U. S. Dept. of Agriculture.)

gone. I did not notice any of the moths last year, but now (June 15), the moths are thick, and I send you a few to examine. I should like to know what these are, although they did me no harm last year; in fact, they saved me a day or two's work cutting weeds, but I might not have a field of pigweed ready for them when they come again.'

The Sugar-beet Webworm can hardly be described as a green caterpillar, because it is dark black, with greenish yellow stripes, but, strange to say, almost every correspondent who mentioned it referred to it as a green caterpillar. As, however, in most instances specimens of the caterpillars accompanied the inquiries, there was no doubt as to the identity of the species, which has been kindly supplied to me by Dr. Dyar, of the Division of Entomology, at Washington. It would appear from the dates when caterpillars are mentioned by observers in Manitoba, that there were two broods of this insect last summer. The life history of the species has been carefully worked out by the Division of Entomology at Washington, and illustrated articles have appeared upon it in 'Insect Life,' V. and VI., and in the recent Bulletin 43, by Mr. F. H. Chittenden, on the 'Principal Insect Enemies of the Sugar-beet.' The excellent illustrations given herewith have been kindly lent to me by Dr. Howard and were used in the last named bulletin.

The following letter gives some idea of the range of plants liable to be attacked by these caterpillars. There is no doubt that the normal food plant is the Lamb's-quarters or Wild Spinach (*Chenopodium album,* L.), often called pigweed.

'Deleau, Man., July 21.—We have had a visitation from a pest that I have never seen before in my 21 years' residence here. About two weeks ago we noticed the pigweed on land left for summer-fallowing covered with a greenish worm, samples of which I send you. In a day or two these swarmed into the garden in millions. They scarcely touched potatoes, beans or corn, but devoured turnips, beets, cabbages, onions, carrots, currant bushes, and even crap-apple leaves. We made a vigorous fight to save something, making narrow trenches for them to fall into, and tried various poisons, but without avail; so, we stuck systematically to knocking them into tin pans and emptying these into pails of water with coal oil in them. In this way we caught several pailfuls in a day. They have now almost disappeared but have left the garden in a very dilapidated condition. As soon as we noticed them coming off summer-fallow, we ploughed the land next to our garden, but they swarmed over on top of the ploughing. They seem to be good travellers. I should like to know what they are.'—J. E. Marples.

Specimens of the caterpillars were sent, without any letter being received, from Mr. H. L. Patmore, of Brandon.

Mr. Norman Criddle, of Aweme, sends the following notes :

'Sept. 5.—Do you remember mentioning when here a small prairie moth, which one of your correspondents was afraid of as a possible enemy of wheat. I am sending you now what I am pretty sure are the larvæ of the moths you showed me. These caterpillars are here now simply in enormous numbers, more so than anything of the sort I have ever seen. They clear off all the food before them and then march on in a regular swarm, all going the same way. The food plant seems to be usually lamb's-quarters, but this has been all eaten clean, and they are now turning their attention to wild buckwheat, the native asters, the tumble-weed *(Amarantus),* sand cherry, red cherry, rose, red-root pigweed, and even wheat and oats, as well as numerous other plants. Fortunately, they are too late in the season to do much harm, and in any case they seem to prefer weeds to grain. The moths were very abundant during June and July.'

'Sept. 27.—The larvæ have now all disappeared beneath the ground, but whether to hibernate or pupate, I am not quite sure. Several that I dug out had not yet undergone any change, but had merely made a straight burrow about two inches deep, which

they had lined somewhat loosely with web. In reply to your letter, the food preferred to all others is lamb's-quarters, and wheat was only attacked when all other plants had been eaten. So far, instead of this insect being an enemy, the caterpillars have proved undoubted friends.'

'Oct. 18.—I went out this morning to try and find out for you whether the larvæ of *Loxostege sticticalis,* L., had turned to pupæ or not. I found they were all hibernating as larvæ, as you suspected. They are from one to two inches beneath the ground in a closely woven chamber of web, and they are now very sluggish.'

The Sugar-beet Webworm is stated by Mr. Chittenden in his bulletin, to be an introduced insect from western and central Europe and northern Asia, which is evidently slowly but steadily pushing its way eastward. From the letters given above, it is quite apparent that the outbreak of last summer was exceptional, and also that the favourite food plant is the well known and troublesome weed of western wheat fields, the lamb's-quarters, and allied plants. As, however, the sugar-beet is one of these and great efforts are being made in the West to foster the cultivation of this crop, it seems important to make the appearance and habits of this insect well known. The most important points with regard to these are as follows : The pale yellow eggs are laid singly or in rows of two to five, overlapping like fish scales. The young larvæ are at first whitish, with polished black heads and bristle-bearing spots. They soon become blackish caterpillars with thin skins, through which the green contents of the body show. These are very voracious and very soon strip plants of their leaves. The caterpillars appear in July and early September. Pupation takes place in the ground, not deeper than two inches beneath the surface, consequently they can be reached and disturbed by the teeth of an ordinary cultivator at the time they are in the delicate chrysalis condition. Actual experiments are reported by Dr. Howard (Insect Life, VI., p. 37) to have been successful with the winter brood. It would doubtless be so with the summer brood. Prompt attention in spraying an infested crop with arsenical poisons will certainly control this insect should it ever become troublesome in crops of sugar beets. Such plants as spinach in gardens could not, of course, be treated with poison. In those cases, mechanical means of prevention as ditching, might be tried.

FRUIT CROPS.

A satisfactory feature of the year 1903, like that of the previous year, has been a marked decrease in the injuries caused by some of the well known pests of the fruit-grower. The Tent Caterpillars, Cankerworms, Squash Bugs, and even the Codling Moth, in most places may be said to have done hardly any harm. Fruit crops have been exceptionally remunerative. The apple crop in Nova Scotia was a remarkably good one, large in quantity and excellent in quality, being very free from insect attacks as well as from Black Spot and other fungous diseases. (B. W. Chipman.) In Prince Edward Island the crop was 'rather poor, having been injured by the late frosts and dry weather in spring.' (E. J. McMillan.) Through Quebec and Ontario the crop on the trees was not so large as in some previous years, but the quality was so exceptionally good that there was a larger quantity of A 1 fruit for export than has been the case for several years. Only in the west of Ontario was any trouble experienced with Black Spot fungus, or insect enemies. In British Columbia apple crops were somewhat reduced by the attacks of the Apple Aphis, but the output was larg and of excellent quality. The poor crop of apples in England last season gave Can dian growers a good opportunity of showing to what exceptional excellence this valu able fruit can be grown in this country, and the large quantity shipped up to the end of November, over 1,000,000 barrels, with a probable total export of 2,000,000 by the

end of the season, as well as the high quality of the fruit, will no doubt make a lasting impression on the British market.*

'There was a fair yield of apples; but in various parts of the province of Ontario complaints were made of the scarcity of barrels, and, on this account, buyers were more particular than ever in the selection of this fruit; thousands of bushels of apples that in former years would have passed for shipment to Great Britain, were this season rejected by them.'—(C. C. James).

Not only was the quality of the fruit exported this year better for the above reason, but the rigorous application of the 'Fruit Marks Act' has prevented much second-rate fruit from going forward, which otherwise would have found its way to the British markets. This will be a decided and lasting benefit to the country. Grapes were a good crop in the Niagara peninsula, but in Essex and Kent the crop was practically destroyed by the Black Rot of the Grape *(Læstadia Bidwelli,* V. & R.) Plums were an enormous crop in almost all parts of the Dominion, injuries by the Plum Curculio being considered this year rather a benefit than otherwise for the work they did in thinning fruit on the overloaded trees. The only discounted reports as to plums were from some parts of the maritime provinces. In British Columbia considerable loss occurred from the attacks of the fungous disease known as Brown Rot or Ripe Rot (*Monilia fructigena*), which attacks the fruit just when it is ready for the market. This loss was chiefly on Vancouver Island and near the coast on the mainland. Orchards which had been sprayed early in spring and where the diseased plums had been carefully gathered and destroyed, were noticeably freer from attack than where no remedial measures had been adopted. The Shot-hole Fungus (*Cylindrosporium padi*) also did considerable injury by defoliating the trees before the fruit was ripe. This, like the last named disease, can be controlled by regular spraying. Peaches were an enormous crop of excellent quality. Cherries were fair on Prince Edward Island, good in New Brunswick and Nova Scotia, excellent and abundant in Quebec, Ontario and British Columbia. The pear crop is reported as good; but the ravages of the Pear-tree Slug were serious in some places, and the Pear-tree Flea-louse is reported by Prof. Lochhead as having been very injurious in the Grimsby district of Ontario. On the fruit farm of Mr. W. R. Dewar, trees were much stunted and were covered with the dirty black fungus, *Fumago salicina*, which develops upon the honeydew emitted by this insect and various other kinds of plant-lice. Berries and small fruits generally were seriously affected by the drought of early summer through the region where this prevailed. The rains, which came about the middle of June, were too late to save the strawberry crop but helped considerably raspberries and currants. Cranberries in Nova Scotia did not produce such a paying crop as usual, but this was not due to any trouble with insect enemies. In Prince Edward Island this crop was reported as 'fair.'

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* The following extract from the 'Glasgow Herald' of January 5, 1904, in an article upon the Fruit Imports into the United Kingdom in 1903 is significent: 'Green Fruit Import. The apple trade was unique, 1903 being a bumper year. The total weight was 4,550,000 cwt. valued at £2,850,000. In ten years the imports have been nearly doubled; 1903 even surpassed 1896, which was the most prolific season of recent years. The imports in favour of 1903 against 1896 are 3,000,000 bushels. We get the largest parcels from the United States and Canada. These countries send us more than 2,500,000 cwt. annually. Of course, the Canadian apples are much superior to those of the United States.

OYSTER-SHELL BARK-LOUSE (*Mytilaspis ulmi*, L=*M. pomorum*, Bouché) has been complained of from almost every part of the Dominion where fruit trees are grown; and the chief reason that it remains unchecked and continues to increase, seems to be that it is so often overlooked by fruit growers and others who ought to know such a common and destructive enemy by sight and also be well acquainted with the best means of fighting against it. In south-western Ontario excellent work has been done in preventing the spread of this scale by the minute chalcid parasite, *Aphelinus mytilaspidis*, LeBaron. The presence of the parasite in a district can be detected by the minute round holes left by the tiny parasites where they have eaten their way out through the tops of the old scales. This minute friend is so small that it can hardly be seen with the unaided eye. It is bright yellow in colour, with golden eyes, and measures only about one thirty-sixth of an inch in length. Under a magnifying glass, it is found to be a four-winged fly shaped as shown in the enlarged figure herewith. This parasite is sometimes so abundant that it destroys more than half of the scales which are formed. It has occurred in all parts of Canada but never seems to remain long in any district, a fact which is rather remarkable, as the Oyster-shell Bark-louse upon which it feeds is abundant everywhere. For the last year or two it has been noticed in large numbers upon scale-infested fruit trees in the Niagara district. There is only one brood of the Oyster-shell Bark-louse in the year. The young bark-lice emerge from beneath the old scale in Ontario and British Columbia about the end of May, and in the maritime provinces towards the end of June. At that time they are small six-legged insects resembling mites. After emerging, they wander about the trees for a few hours, looking for a suitable place to attach themselves to the bark, which they do by means of their slender beaks. Once having attached themselves, they never move from that place ; gradually their legs disappear, with the increase in size of their bodies, and a waxy scale is secreted over them. By the middle of August the female bark-louse has practically changed into a bag of eggs protected by a scale. Little by little the body of the mother insect dries up ; and, when all of her eggs are laid, the scale is well filled with these minute white objects, and the mother's body is merely an empty skin at the small end of the scale. The scales of the male bark-lice are seldom noticed. They are of different shape and, as a rule, occur on the leaves. They are much smaller than those of the female and are long, narrow and white. (Fig. 12*c*.) The perfect male is a tiny winged insect which is able to fly well.

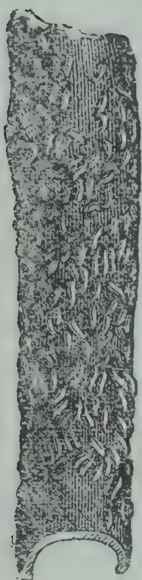

Fig. 10.—Twig infested with Oyster-shell Bark-louse.

Fig. 11.—*Aphelinus mytilaspidis.*

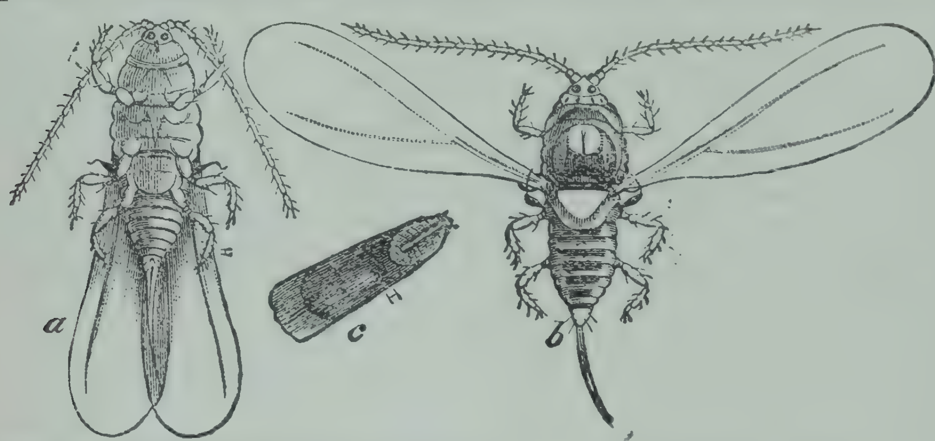

Fig. 12.—The Oyster-shell Bark-louse: *a*, *b*, male adult ; *c*, male scale—much enlarged.

Trees upon which this insect occurs, are weakened by being robbed of their sap by these small insects, which frequently occur in such enormous numbers as

almost to coat the trees and entirely hide the bark. Although so destructive in all parts of Canada, the Oyster-shell Bark-louse is not a particularly hard insect to control, where trees are attended to regularly. The first step to take when an orchard is found to be attacked is to invigorate the trees by ploughing round them and feeding them with some quick-acting fertilizer, such as well rotted manure, or a dressing of wood ashes. When trees have been standing in sod, it is well to break this up. Trees which are planted too closely, should be pruned and cleaned out, so that they may be easy of access for spraying and other operations. As soon as winter has set in, the trees should be sprayed thoroughly with a thin lime wash, one pound of lime in each gallon of water. Two coats must be applied, the second immediately after the first is dry. Where the lime-sulphur-and-salt wash is used to protect trees against fungus and insect enemies, there will never be any trouble with the Oyster-shell Bark-louse. The young bark lice emerge from their mothers' scales during June ; the exact date should be watched for, and, immediately the dust-like yellow mites are noticed, the trees should be sprayed without delay with weak kerosene emulsion, or a whale-oil soap solution, using one pound to six gallons of water.

The SCURFY BARK-LOUSE (*Chionaspis furfura,* Fitch.)—In western Ontario this bark-louse has become so abundant recently, that many fruit growers are noticing it. In several cases, it has been mistaken for the San José scale and has been sent in for that insect. It is only occasionally that this scale develops in sufficient numbers to injure trees seriously. When it does so, it can be treated in the same way as the Oyster-shell Bark-louse. Mr. W. W. Hilborn found it was entirely destroyed by the lime-sulphur-and-salt wash. The eggs of the Scurfy Bark-louse are bright red in colour and are to be found beneath the scales by the middle of August or early in September. The male scale, as in the case of the Oyster-shell Bark-louse, is of quite a different shape from that of the female. In both sexes the scales are white and so closely appressed to the bark that they are easily overlooked or are not recognized as scale insects. The male scales are frequently found all clustered together in groups around the base of a twig or at some inequality of the bark.

The EYE-SPOTTED BUD-MOTH *(Tmetocera ocellana,* Schiff).—The insect concerning which most inquiry was received from Nova Scotia last spring, was the Eye-spotted Bud-moth. Attention had already been called to it by its frequency in Nova Scotian orchards during the previous year, and specimens also came in from some parts of Ontario and Quebec and from one point in British Columbia. Prof. F. C. Sears, Director of the Nova Scotia School of Horticulture, of Wolfville, N.S., writes at the end of the season: 'Even the Bud-moth, which for the past few seasons has been extremely abundant, proved much less troublesome than was anticipated. This was undoubtedly due in large measure to the fact that our orchardists now understand it better and apply the early spraying, by which it is best controlled. We find that this early spraying should be applied from May 1st to 10th, according to the season. I am glad to report that spraying was much more general during the past season than ever before, particularly in Annapolis County. One dealer there sold one hundred spraying outfits ; but, as the season was particularly unfavourable for fungous pests and most insects, I fear that some that sprayed for the first time may be discouraged.' It was suggested by Mr. E. E. Archibald, of Wolfville, N.S., that the irregularity in the fruit crop in the celebrated Annapolis valley of Nova Scotia might be due to the depredations of this small but very destructive and frequently unrecognized enemy. I believe that his suggestion was in a large measure correct and, where correspondents had reported a blighting of the leaves and fruit buds, I am sure these results had been in many cases directly due to the attacks of the caterpillars of the Eye-spotted Bud-moth. On account of its abundance last year, it will be wise for fruit growers to examine their trees during the present winter and early next spring, to see if there are any of the

small brown caterpillars upon them, and, should they find any, to be prepared to spray their orchards thoroughly, just at the time the buds are bursting, with a poisoned Bordeaux mixture, this being the remedy,—of many which have been tried,—which has given the best results. This mixture, made according to the formula which we use at the Experimental Farm, is as follows:—

Copper sulphate (bluestone)	4 lbs.
Unslaked lime	4 lbs.
Paris green (for Bud-moth and other leaf-eating insects)	8 oz.
Water (one barrel)	40 gals.

Dissolve the copper sulphate by suspending it inside a cotton bag in a wooden or earthen vessel containing five or more gallons of water. Slake the lime in another vessel, and then strain the lime wash through coarse sacking or a fine sieve. Pour the copper sulphate solution into a barrel, or it may be dissolved in this in the first place, and fill the barrel with water. Stir thoroughly before using. A stock solution of copper sulphate, and lime wash may be prepared and kept in separate covered barrels through the spraying season; but the quantities of copper sulphate and lime in the solutions should be carefully noted, so that the proper strength may be used when a wash is required for spraying.

The caterpillars of the Eye-spotted Bud-moth pass the winter on the twigs of trees, upon the foliage of which the eggs had been laid the previous summer. Each caterpillar is snugly curled up inside a small silken tent or covering called a pseudo-cocoon. These are extremely difficult to find until their appearance is known. They are located, as a rule, right in the crotch between two twigs, or in any small depression on a fruit spur. In many instances, I have found that a small piece of leaf or of lichen, is attached to the outside. On opening these with the tip of a knife, the small brown black-headed caterpillar, one-eighth of an inch in length, will be found inside. These caterpillars when they go into winter quarters are less than half-grown, having passed through three or four of their six moults. Early in spring, just before the time that the leaf buds burst, they emerge from their shelters and attack the opening leaf and flower buds. They do a great deal of harm at this time because they not only devour the young leaves but a single caterpillar will destroy a whole cluster of flowers. Their injuries are severe, both upon young trees and also upon full-grown bearing trees, which in some instances have been stripped of almost every bunch of flowers. These caterpillars become full-grown during June and then spin cocoons among the dead leaves which they have injured. The small gray and white moths appear during the month of July. These moths are similar in shape and size to the Codling Moth but are of a general dark gray colour, blotched with white, which makes them very inconspicuous when they are at rest on the trunks of trees. They measure about three-fifths of an inch across the opened wings and may be recognized by an eye-like spot upon each of the fore wings. The moths appear from June to the middle of July ; they rest on the trees during the day time but are very active at night, flying about fruit trees and laying their eggs upon the leaves. The eggs are remarkable little objects which lie very flat upon the leaf on which they are deposited. Under a magnifying glass, they have more the appearance of minute drops of water, or of tiny fishes' scales than of the eggs of an insect. Ten days after the eggs are laid, the young caterpillars hatch, and their habits during the summer are quite different from those of the spring. As soon as the caterpillars hatch, they crawl to the middle of the lower side of the leaf and form a silken tube close to the midrib of one of the larger veins. Here they feed upon the tissues of the lower side of the leaf, leaving the network of veins and the upper surface of the leaf. As they extend their operations, they cover themselves with a light tent of silk. They grow slowly, remaining for eight or ten weeks on the same leaf where they were born ; they then stop feeding and crawl from the leaves to a con-

venient place on the twigs, where they spin their winter coverings. This generally takes place, Professor Slingerland found, in the first half of September, and is done irrespective of the weather, even if it be fine and hot, and there is abundance of food. Like all other insects, they seem to know instinctively that it is the proper time for them to prepare for winter. The spring appearance of the caterpillars, on the other hand, is much less regular as to date and will vary as much as three or four weeks, according as the spring and the time of the opening of the buds is early or late. However, it may be generally stated that the caterpillars leave their winter quarters and begin their depredations at the time the leaf buds open. There is only one brood of this insect in the year, the caterpillars which attack the leaves in the late summer, being the same ones which destroy the leaf buds the following spring. The moths appear at only one period in the year, viz., during the three or four weeks from the middle of June till the middle of July. Since the life-history of this insect has been discovered, better remedial measures have been devised than were previously known. The fact that the caterpillar passes the winter half-grown, accounts for the large amount of injury which is done so soon after growth begins in spring. The Eye-spotted Bud-moth attacks, besides the apple, the plum, the peach, the pear, the quince and the blackberry.

The remedy which, as stated above, has given the best results, is to spray the trees thoroughly with a Bordeaux and Paris green mixture at the time the buds are opening, covering the whole tree so that every bud may receive its share of poison. The Bordeaux mixture will also, when applied at that time, materially hold in check the troublesome Black Spot disease of the apple. There are, of course, many other kinds of poisons which may be used ; but those which have given the best results, are Paris green, Arsenate of Lead or Disparene, and Green and Pink Arsenoid. Where great care is exercised in mixing and making the application according to instructions and also in destroying carefully all surplus left on hand after spraying, white arsenic in any of its combinations may be used and will destroy all leaf-eating insects, upon trees which have been sprayed with a mixture containing it ; but its use is attended with considerable danger to foliage and also with great risk to animal life, including human beings, from having about a house or outbuilding a substance which so closely resembles so many materials used in a household. In Prof. Bailey's most useful little Horticulturists' Rule Book, under the head of arsenic, we find the following:—' Arsenic.—Known to chemists as arsenious acid or white oxide of arsenic. It is considered an unsafe insecticide, as its colour allows it to be mistaken for other substances; but in its various compounds it forms one of our best insecticides. From one to two grains, or less, usually prove fatal to an adult; 30 grains will usually kill a horse, ten grains a cow, and one grain, or less, is usually fatal to a dog. In cases of poisoning, while awaiting a physician, give emetics ; and, after free vomiting, milk and eggs. Sugar and magnesia in milk is useful. In the very complete experiments which have been recently carried out under the instructions of Dr. L. O. Howard, the United States Entomologist, by Mr. C. B. Simpson, on the Codling Moth, the following important statement is made as to the insecticide which he found most useful in his extensive investigations:—

'Arsenite of Lime with Soda.

White arsenic..	pound	1
Sal soda (crystal)	pounds	4
Water..	gallon	1

'The ingredients are boiled in the required amount of water until dissolved, which will take place in a comparatively few minutes, after which the water lost by evaporation is replaced. To every 40 or 50 gallons of water a pint of this stock solution and from 2 to 4 pounds of fresh slaked lime are added. The chemical com-

pound derived from the combination of the sal soda and the white arsenic is arsenite of soda. In the presence of lime this breaks down and arsenite of lime is formed. It requires 4·4 pounds of crystal sal soda, or 1·6 pounds of dry sal soda to combine with one pound of arsenic, and 2 pounds of freshly slaked lime to combine with one pound of arsenic to form arsenite of lime. It is always desirable to have an excess of lime present, in order to prevent all danger of burning; furthermore this excess is a convenience to fruit growers, because they can see by the distribution and amount of lime on the foliage how well the spraying has been done. The formula, which is the Kedzie formula with a few minor changes, has been used in many different sections of the country with unvarying success. In all of the practical tests under the advice of the writer, this solution is used and is found to be, not only as efficient as other solutions, but far cheaper.'

'When it is desired to use Bordeaux mixture with this solution, it is added to the Bordeaux mixture in the same proportion as to a similar quantity of water.'

The above quotation is given here because I am aware that many fruit growers in different parts of Canada are using white arsenic in some form for spraying fruit trees in preference to Paris green, and moreover because considerable injury has followed this practice, which has to a certain measure served to discredit the most important practice of spraying fruit trees for the prevention of injury by leaf-eating insects. In my own experience, I prefer to use Paris green, knowing it to be perfectly effective and believing that, notwithstanding the fact that it is a little more expensive than some other arsenical insecticides, it yet repays enormously any expenditure by the improved condition of sprayed trees; but, if other substances are used, probably the Kedzie mixture is the best. Disparene, or arsenate of lead, is also another very valuable insecticide, one great feature in its favour being the length of time it remains effective on the foliage. Mr. Joseph Tweddle, of Fruitland, Ont., who not only himself grows very satisfactory crops in orchards which he has sprayed, but has also done much work in spraying orchards for other fruit growers, who have been well satisfied with the treatment used by Mr. Tweddle, tells me that the spray which he uses is made as follows:—'I boil half a pound of white arsenic in one gallon of water with one pound of lime for 45 minutes, and make up to the original quantity of water when it is finished boiling. I use this in 50 gallons of Bordeaux mixture for apple and pear trees, except for the third or fourth treatment when it will sometimes burn the foliage if used at this strength. I have never used it on plums and cherries at the above strength without doing some injury, and would always advise care in spraying so as not to drench the trees. I find this mixture very effective against all leaf-eating insects. When spraying peach trees for Curculio I use this mixture of half the strength without the Bordeaux mixture, and when with the latter not more than one quarter strength.'

Prof. C. P. Gillette, of Colorado, recommends a somewhat simpler method of preparing arsenate of lime, which is to boil for three-quarters of an hour one pound of white arsenic and two pounds of fresh lime in one gallon of water, and of this he uses one quart to an ordinary barrel of 40 gallons. Prof. Gillette also draws particular attention to the necessity of using fresh lump lime and of exercising the greatest care in labelling everything containing this mixture plainly 'Poison.'

The proportions in which I have found the best known arsenical poisons satisfactory, are as follows :

Paris green—1 pound to 160 gallons of water, with 1 pound fresh lime.

Arsenate of lead—1½ pounds to 50 gallons of water.

Green arsenoid—1 pound to 160 gallons water, with 1 pound fresh lime.

The APPLE-LEAF SEWER [*Ancylis (Phoxopteris) nubeculana*, Clem.].—Apple orchards at Fruitland, Grimsby, St. Catharines and Niagara-on-the Lake, were to a moderate extent infested last autumn by the small caterpillars of this insect. The sewed leaves were conspicuous on the trees in autumn. Inside these leaves, which fall to the ground, the caterpillars remain until the following spring, when they change to chrysalids; and the pretty moths, which are shown at fig. 13, appear in May and June. The chrysalis works its way through the leaf, and, when the moth escapes, the empty skin remains attached to the leaf. This insect has never been a serious pest to the apple grower, and is only sometimes sufficiently abundant to attract notice. The only remedy which has been recommended, is to rake up the leaves in the autumn and burn them.

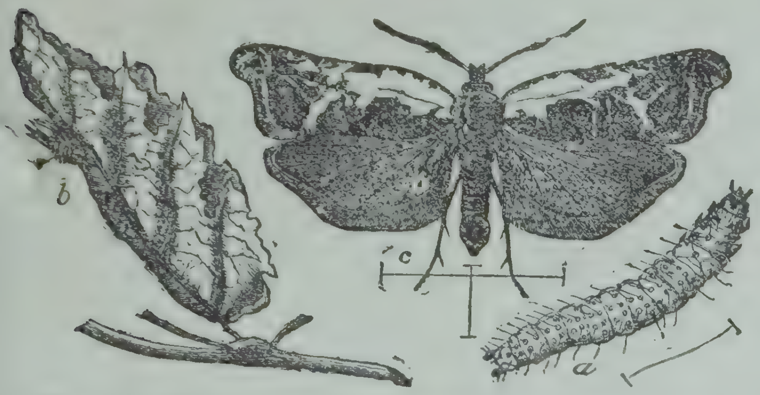

Fig. 13.—The Apple Leaf-sewer: *a*, caterpillar; *b*, pupa case on leaf; *c*, moth—*a* and *c* enlarged.

The APPLE-LEAF MINER (*Tischeria malifoliella*, Clem.)—Rather more abundant than the above and more destructive was this small leaf-miner. It occurred in several orchards near Grimsby, and Mr. Joseph Tweddle reports it as being sufficiently abundant to require attention. It has been noticed more or less in this same district for several years, specimens having been sent once or twice by Mr. Geo. E. Fisher, of Freeman, Ont., who had noticed it in orchards and nurseries in the above named district, when inspecting for San José scale. I do not think that it is ever likely to develop into a serious enemy, but it is advisable for students of insects to find out a little more than is at present known concerning its exact life history, so that, in case it ever requires special treatment, we may be prepared with a practical remedy, which as yet is wanting. The only remedy now suggested is to burn the fallen leaves in infested orchards, either in autumn or before the moths leave them in the spring.

The APPLE APHIS (*Aphis mali*, Fab.).—Plant-lice of all kinds have been noticeably abundant on many crops throughout Canada and the northern United States during 1903. Although this has been the case, it cannot be said that their injuries have been excessive, for in nearly every instance, they were attended by large numbers of their natural parasites, which soon reduced the numbers so much that they were unable to do appreciable harm. The only injuries which could be considered serious, were where the insects attacked young stock in nurseries and fruits while young. Some of our large nurserymen in western Ontario inform me that Apple Aphis did them considerable harm last season, particularly upon budding stock, late in July and in August. In Prince Edward Island and in British Columbia, an injury which I have already alluded to as caused by the Apple Aphis, was again this year apparent on apples. This injury is of a serious nature, and takes the form of deep pits which are left on the growing fruit at spots where apples have been punctured by the aphis when they were small. This gives the fruit a distorted, gnarled appearance which renders it quite unsaleable.* As a general thing, except in British Columbia, it is not advisable to go to the expense of spraying bearing apple trees for destroying the Apple Aphis. The insects are most abundant when they first hatch from

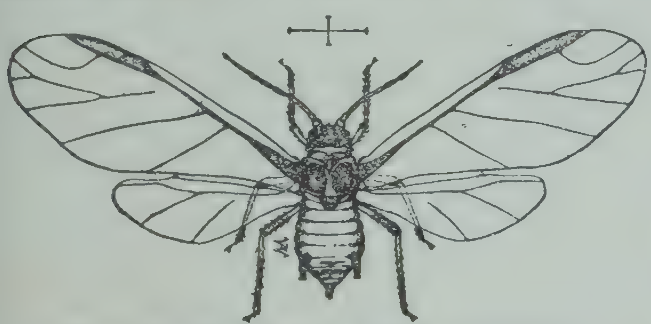
Fig. 14.—The Apple Aphis—enlarged.

*See Fig. 15, next page.

the eggs, in which form they pass the winter. At that time the plant-lice cluster on the buds to such an extent as to almost hide them. With the rapid expansion of the foliage, they are soon lost sight of, and it is very seldom that serious injury results from their presence. Late in the autumn, when they come back again to apple trees after passing some time on grasses and fall wheat, they are again found in large numbers upon apple trees, where they lay their eggs. In British Columbia, this insect is one of the most destructive orchard pests the fruit-grower has to deal with, and treatment of infested trees is frequently a necessity.

It may also be noted that, although the Apple Aphis was troublesome last season in many parts of the Pacific province, Mr. Venables expressly states that the Apple Aphis was less abundant than usual at Vernon, although one might have expected it to have appeared in great force, judging from the large number of eggs laid in 1902. These, however, for the most part failed to hatch last spring. The Apple Aphis is a green plant-louse, having the head, the eyes and the thorax black. The head is pointed in front, and the prothorax has lateral tubercles. The antennæ are shorter than the body. On comparing this species with the Grain Aphis, which very much resembles it, the most striking differences are that in the latter species the eyes are reddish, the head and thorax brown and the head not pointed in front. The antennæ, which are a little longer than the body, are also borne on distinct frontal prominences. A remedy which answers well for the Apple Aphis, is to spray the infested trees thoroughly with whale-oil soap, one pound in six gallons of water, or with a tobacco and soap wash made by soaking ten pounds of tobacco leaves in hot water for a few hours, then straining off the liquid and adding two pounds of whale-oil soap. Stir until all is dissolved and fill up to make 40 gallons. If this wash is applied as a spray two or three times at short intervals, little difficulty will be met with in destroying the Apple Aphis.

Fig. 15.—Section of Apple showing distortion of outline.

The injury to apples referred to above resembles very closely that of the small British Columbia Apple-fruit Miner *(Argyresthia conjugella*, Z.), as shown at fig. 15.

The Plum Aphis *(Aphis prunifolii,* Fitch) was mentioned by correspondents several times during June, and trees infested were sprayed promptly with whale-oil soap or the tobacco and soap wash with good effect. In British Columbia an allied species, *Hyalopterus pruni,* Fab., was reported by Mr. E. P. Venables, of Vernon, B.C., as being in greater numbers than for several years past. The insect was also observed at several other places in British Columbia, both on the mainland and in Vancouver Island.

The Cherry Aphis (*Myzus cerasi,* Fab.).—This is a black plant-house, which frequently appears in large numbers early in spring and clusters around the young fruit and along the stems of the fruit and leaves, sucking the sap and doing much harm. The eggs are laid upon the twigs during the autumn, the young plant lice not hatching until the following spring. This plant-louse has done a considerable amount of harm in western Ontario for several years, and during the past summer, although in most places it disappeared early in June, in others much loss resulted from its attacks. Mr. J. B. Fairbairn writing from Bowmanville, Ont., says: 'I have two English cherry trees that for years have had their crop ruined by this pest; two seasons ago I planted out three Montmorencys, and I find they also are covered with these insects. It seems almost impossible to destroy them without injuring the trees.' The Cherry Aphis is one of the class known as Black Plant-lice, and it is a remarkable fact which has not been accounted for, that all of these dark coloured plant-lice are much harder to kill than those which are of a green or light colour. For the Apple Aphis, Hop Aphis and other green-coloured species, one pound of whale-oil soap in 8 or 10 gallons of water is suf-

ficiently strong to destroy them; but, for the black species, I have found that six gallons of water to one pound of soap is the greatest dilution which can be used. An important point, too, in fighting this insect, is early work, because, as the egg is upon twigs all through the winter, and the young hatch there in spring, they are easily reached with a small amount of spraying material, and early treatments before the leaves have expanded, have been found most effective. The kerosene emulsion may also be used with great success at any time after the weather becomes warm in spring, and before the leaves expand. For this purpose, the stock emulsion should only be diluted with six parts of water, instead of nine, as in the usual dilution for use upon foliage.

The RED-HUMPED APPLE-TREE CATERPILLAR (*Schizura concinna*, S. & A.).—These voracious caterpillars were sent in from Nova Scotia, Quebec and Ontario, and were reported from British Columbia. Altogether, the species seems to have been rather more abundant than usual. The appearance of these caterpillars is well shown at fig. 16. The colours are as follows:—Head bright red, as is also a conspicuous hump on the fourth segment. The sides are striped with black, yellow and white lines. The blunt spines on the back are black. When at rest, the end of the body is raised and has, when viewed sideways, somewhat the shape of a dog's head. When full grown in autumn, they are a little more than an inch long. They then spin close parchment-like cocoons among the leaves on the ground, or a short distance beneath the surface, in which they remain unchanged until the following spring, when they assume the chrysalis condition, and the moths emerge towards the end of June. These are plainly coloured but prettily marked in varying shades of brown, which make them very inconspicuous when at rest, and, although the caterpillar is common, the moths are very seldom seen. These, when the wings are opened, expand from an inch to an inch and a half, the males, as a rule, being much smaller than the females. The eggs are deposited in clusters on the leaves of apple trees and occasionally on a few other kinds of trees, as willow, birch and oak. They are laid early in July, and by the end of that month the colonies of young caterpillars become conspicuous from the thorough way in which they strip whole branches of their leaves. At this time much good may be done by cutting off the branches and destroying the whole colony at once, as they very seldom wander far from each other, and when at rest, are massed together so as to hide the twigs and stem of the branch. The Red-humped Apple-tree Caterpillar has never appeared in Canada in sufficient numbers to be the cause of much loss to fruit growers, and, where trees are regularly sprayed with insecticides, this will never be the case. The species is much rarer in British Columbia than in the East, but I have on several occasions seen colonies upon wild willows, as well as upon apple trees in orchards. Mr. E. P. Venables reports it as more abundant than usual in 1903 at Vernon in the Okanagan valley. Prof. F. C. Sears sent specimens from Wolfville, N.S., Mr. P. E. Choquette, from St. Jerome, Que., and Mr. E. B. Yarwood, from Picton, Ont. A few colonies were also found at Ottawa.

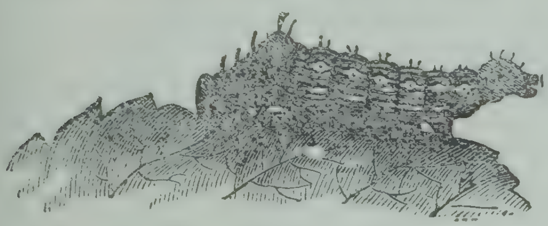

Fig. 16.—The Red-humped Apple-tree caterpillar.

The PEAR-TREE SLUG (*Eriocampa cerasi*, Peck).—The slimy blackish slug-like larvæ were last year, as is too frequently the case with so easily controlled a pest, found very destructive in British Columbia to the foliage of pear and cherry trees. Specimens were also sent from Morrisburg, Ont., by Mr. Gordon Dill. The parent insect is a short, thick four-winged fly, about a quarter of an inch in length. It is glossy black, with pale legs, and has the habit, when an infested

Fig. 17.—The Pear-tree Slug.

tree is touched, of drawing in the legs and falling to the ground. There are two broods in a season, the flies of the first brood appearing and laying their eggs early in June. These are inserted into the tissues of the leaf, where they remain for about a fortnight before the young slugs hatch. The greatest injury is done to fruit trees during July. The larvæ are sometimes, and indeed very frequently, in such enormous numbers as to strip the green cellular tissue from the leaves to such an extent that the foliage of whole trees and even of orchards is destroyed, and the trees are left apparently covered with only dead leaves. This injury, occurring as it does when the trees require the full use of their leaves to bring the fruit to perfection, is a serious one, and its effects last over and affect the crop of the second year. A second brood of larvæ appears in August and September. These, when fully fed, fall to the ground and penetrate a short distance beneath the surface, where they remain until the following year, changing to pupæ about the middle or end of May, and the flies emerge soon afterwards. The Pear-tree Slug, which, as its latin name indicates, attacks also the Cherry-tree, is a very easy insect to control. In properly managed and sprayed orchards it can never be troublesome. Owing to the viscid secretion on the skin any dry, dusty material adheres to it and causes the insect great inconvenience; therefore, dusting trees with freshly slaked lime or even with finely sifted road dust, will have the effect of clearing trees of large numbers. Two or three applications should be made at short intervals. In hot, dry weather dusting trees either by hand or with an insect gun or other implement for the distribution of dry powders, for two days running, I have found quite satisfactory. The material used was freshly slaked lime, to which Paris green was added in the proportion of one pound to fifty, so that in case any of the larvæ, which might have been moulting, escaped, there would still be on the foliage poison to destroy them as soon as they began to feed. The most practical remedy is undoubtedly to spray trees with Paris green or some other arsenical insecticide, one pound to 160 gallons of water. This treatment will not only destroy the Pear-tree Slug but also many other kinds of leaf-eating insects.

The PEAR-TREE FLEA-LOUSE (*Psylla pyricola*, Foerster).—Although up to the present time the Pear-tree Flea-louse, called also the Pear-tree Psylla, has not been the cause of widespread injury, still there are every year complaints of more or less serious loss in pear orchards in western Ontario. I have found this insect to be abundant when looked for in orchards, throughout the Niagara district and along the north shore of Lake Erie. During the last summer I have had it sent to me from two localities in Nova Scotia, and believe it to be also present at other places from which no specimens have been received. Prof. Lochhead, of the Ontario Agricultural College, writes me as follows :—

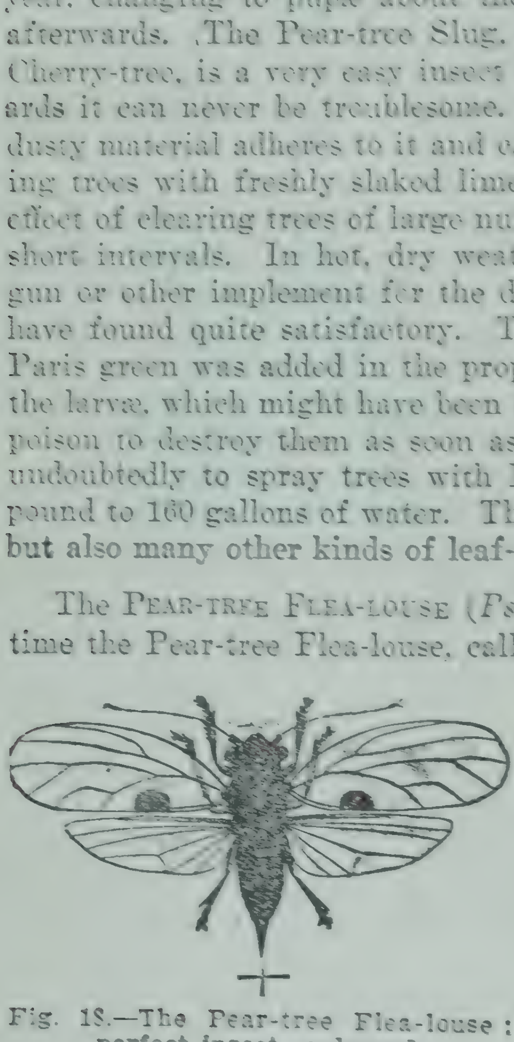

Fig. 18.—The Pear-tree Flea-louse: perfect insect—enlarged.

'This insect has been very injurious this past season, more especially in the Grimsby district.' A correspondent writes :—'When I came home on July 4, many trees were fairly covered with it. The insects were mostly wingless, with a few winged forms. They are found in the axils of the leaves, along the petiole and along the blade, but are chiefly found on the leaves a short distance from the vein or just in the axils of the secondary veins or mid-veins. In the first place, the tissue of the leaves dries up in spots where they are situated; but in the latter case they cause a drying of the tissues along the edge of leaf at the outer extremity of the vein. When the psylla is situated in the secondary axils of the leaf, the petiole seems yellowish in colour and the attachment to the stem seems weak. About July 15 to 25 the psyllas were most abundant—the number of winged forms increasing until the 25th. A heavy rain on the 23rd cleared the trees of the honey-dew, and seemingly of quite a number of the psyllas. After another heavy rain on the night of July 27, I noticed

that there were very few of the wingless forms, but a great number of the winged ones. Up to this time very few leaves had fallen off, although the growth of the trees was completely stopped; in fact, our trees have apparently made no growth at all this year, excepting a few that were free from the Psylla. At the time of writing, August 27, the wingless forms have again become numerous and the winged ones few.'—W. R. DEWAR.

Mr. John Chute, of Berwick, N.S., also observed that those of his trees which were infested by the Pear-tree Flea-louse made no growth.

This insect was first noticed as injurious in Canada in 1894, and a short account of it, with the best remedies for controlling it, appeared in my annual report for that year. The attack may be described as follows:—Small clear-winged insects, wedge-shaped like miniature cicadæ, the head being broad, flat in front, and the body pointed behind; one-tenth of an inch in length, of a reddish brown colour, with broad black bands across the abdomen. These insects, at the slightest disturbance, leap from the foliage of infested pear trees and fly for a short distance. With the above described form, there will be found on the leaves the curious flattened oval larvæ, which, when first hatched, are extremely small, only one-eightieth of an inch in length, of a semi-translucent yellow colour, with bright red eyes. These grow rapidly, and in about a month pass through five nymph stages, during which the body retains its flattened form and becomes much darker until, in the full-grown nymph, the large wing-pads and the greater part of the upper surface are black. The eyes and sometimes the body between the black markings are crimson. The presence of this insect upon trees is easily detected by the copious secretion of honey-dew with which the leaves, limbs and trunks of the trees soon become covered, and upon which the dirty looking Sooty Fungus *(Fumago salicina)* develops. After a time the leaves and young fruit fall off and the trees assume an unhealthy, gnarled appearance. Hardly any new growth is made, and in cases of severe attack, trees die.

The life-history of this insect has been carefully worked out by Prof. Slingerland, of Cornell University, and has been fully described in Cornell Bulletin No. 108, published in 1896, as well as in U. S. Div. of Ent., Circular No. 7, 2nd series, by Mr. C. L. Marlatt.

The remedies for this insect are the spraying of the trunks of trees which are known to have been infested, during the winter or early spring, with kerosene emulsion, whale-oil soap solution, or whitewash. This is to destroy the hibernating adults, which pass the winter hidden away beneath flakes of bark or in crevices.

The eggs are laid very early in spring long before the leaf buds expand. After leaving their winter quarters and after the sexes have mated, the females lay their curious pear-shaped and tailed eggs (fig. 19) near the tips of the young wood. The young flea-lice hatch from these about the middle of May or sooner, and immediately begin sucking the sap from such leaves as have unfolded. Mr. Joseph Tweddle, of Fruitland, Ont., tells me that he obtained very satisfactory results in destroying the Pear-tree Psylla in orchards which he had sprayed with the lime and sulphur wash to control the San José Scale. He was under the impression that the mixture destroyed the egg upon the young wood, which is highly probable. It frequently happens that fruit growers do not know of the presence of this enemy in their orchards until they notice their pear trees becoming dirty and black during June, or a little later in the year notice that the leaves are falling. As soon as the insect is noticed in sufficient numbers to cause injury to the trees, these

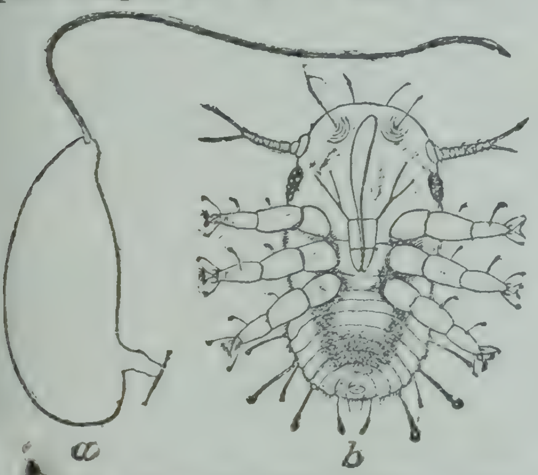

Fig. 19.—Pear-tree Flea-louse: *a*, egg; *b*, larva—both greatly enlarged. (Marlatt, U.S. Dept. of Agriculture.)

latter should be sprayed at once with the ordinary one to nine kerosene emulsion or with a whale-oil soap solution of one pound to six gallons of water. This will destroy large numbers both of the nymphs and also of the mature insects. The most effective work, however, is done during the winter, when nearly all of the adults resort to the trunks and larger limbs for hibernation. In my report for 1900, at page 239, I drew attention to some good work which had been done by Mr. Henry Lutz, of Youngstown, New York State, by spraying with a lime wash. In 1896 a large Duchess orchard belonging to him was almost ruined. In February, 1897, the whole orchard was thoroughly sprayed with whitewash, and two years afterwards this orchard was almost free from Psylla. Mr. Lutz explains his plan as follows:—'During the cold weather in December we spread a canvas under the trees and then scrape off all the rough bark. This dislodges many of the torpid insects, which are burnt with the scrapings. We then give the trees a thorough coating of slushy whitewash made of freshly slaked lime that had been run off in a putty state, as masons usually make it for plastering. We thin this with skimmed milk and put it on the trunks of the trees with a brush, for those parts of the tree which we can reach. We thin down the whitewash with more milk and then give the whole tree a thorough spraying. In this way we destroy a large number of the hibernating Psyllas, and those which are not killed are so well sealed up that they cannot get out to lay their eggs. We spray again in March to coat the wood and buds, so that the few that are alive can find no favourable places to lay their eggs. The orchard where we experimented contained 1,000 trees, which were practically worthless, but since we began using the lime the trees have steadily regained their vigour.'

The PEAR-LEAF BLISTER-MITE *(Phytoptus pyri,* Nalepa).—This enemy has now spread to every part of the Dominion where pears are grown. Specimens were sent from Prince Edward Island by Mr. E. J. McMillan, the secretary of Agriculture for that province, and within the same week in June specimens came in for report from the provinces of Quebec and Ontario. Mr. E. P. Venables, writing from Vernon, B.C., says:—'Pears suffered from the attacks of the Pear-leaf Blister-mite. This insect threatens to become a very serious enemy unless measures are taken to subdue it. I found that the lime, sulphur and salt spray was very useful in destroying it. It was applied just before the buds burst. One tree upon which the leaves were simply black with the work of the mite, was treated thoroughly and the following year was practically free from the insect. A few branches at the top of the tree, however, were as bad as ever. These had not been reached by the spray.'

Frequent experiments have shown that the best treatment for this pest is spraying the trees thoroughly with the lime, sulphur and salt wash just at the time the buds are bursting. The mites pass the winter hidden away securely beneath the bud-scales, which by the expanding of the buds in spring are opened up sufficiently to allow the entrance of liquid. Kerosene emulsion is useful to a certain extent, but sulphur has a specially fatal effect on all mites, and in practice the wash above mentioned has proved the best remedy against the Pear-leaf Blister-mite. See below for receipt of lime and sulphur wash at page 199.

THE SAN JOSE SCALE *(Aspidiotus perniciosus,* Comstock.)

This notorious insect has done much harm in Ontario orchards during the past season. The only part of Canada where the San José scale is now found as an orchard pest is in the Niagara peninsula and in the counties along the north shore of the western end of Lake Erie. The infestation has, however, decidedly increased a great deal during 1903, and has involved new orchards within the area known to be infested at the end of 1902. It is a matter of congratulation that the pest has not spread beyond those limits; for, although most of the leading fruit-growers seem to understand the danger

of neglecting this terrible pest, yet there are many owners of small orchards who are doing nothing whatever to save their trees, and these centres are sources of public danger. An interesting occurrence of the small parasitic beetle *Pentilia misella,* Lec., was brought to my notice by Mr. W. O. Burgess, of Queenston, Ont. This useful little coccinellid was found in some abundance on apple and plum trees infested by the San José scale. It is a well known parasite of that scale insect, and although it has on several occasions been found in considerable numbers in infested orchards, I have never been able to see that it affected the abundance of the scales appreciably.

The Minister of Agriculture still maintains the fumigating stations at Vancouver, B.C., Winnipeg, Man., Windsor and Niagara Falls, Ont., St. Johns, Que., and St. John, N.B.; and a great deal of nursery stock has been passed through them during the past season. A rigorous watch has been kept on every kind of nursery stock which could possibly bring in fresh importations of the San José Scale, and I have again this year the greatest satisfaction in reporting that no single instance has been brought to my notice of living scales having been detected on trees which had passed through the fumigating houses. The superintendents at all of the stations have done their work carefully and well, and no complaints have been received from importers, either as to the slight delay which must occur while the stock is being treated, or as to any injury to the trees during the necessary unpacking, handling and repacking. Careful experiments have shown that the formula used at our federal fumigation stations is thoroughly effective in killing the San José Scale, and does not in any way injure the stock submitted to the gas. The formula used is one ounce of cyanide of potassium (98 per cent), one ounce of commercial sulphuric acid and three ounces of water—exposure, 45 minutes.

During 1903 the experiments which had been carried on up to that time by the Ontario government to discover a practical remedy for the San José Scale were discontinued. After having demonstrated by the excellent work and most careful experiments of Mr. Geo. E. Fisher that this insect could be controlled by practical measures, the Provincial Minister of Agriculture considered it wise not to carry on these experiments any longer. Consequently, during the past summer, although helped with advice and publications by the Provincial Department of Agriculture and Prof. W. Lochhead, of the Guelph Agricultural College, fruit-growers have had to attend to this part of their work themselves. Some have applied the recommended measures and have been quite successful in their efforts when the work was done thoroughly, but the scale has increased to an alarming extent during 1903. The consensus of opinion is that when the well known lime, sulphur and salt wash, or the recent modification of it, in which the salt is omitted, is applied thoroughly as a late winter wash, it is a safe and reliable remedy for the San José Scale. It kills by contact with the scale and acts mechanically by coating the trees so that they are unsuitable for the young scales to establish themselves upon. This wash is used as a winter wash, and should be followed in summer with sprayings of the 1 to 6 kerosene emulsion. The preparation, as described in previous reports and as used to-day in many places, consists of about one pound of lime, half a pound of sulphur and six ounces of salt to every gallon of water in the wash when ready for use. Mr. G. E. Fisher, who tried an enormous number of experiments, found that the results of his investigation justified him in recommending that the salt might be omitted without loss of insect killing power. The original formula of the California wash is :

LIME-SULPHUR-SALT WASH.

Lime, unslaked	40 lbs.
Sulphur	20 "
Salt	15 "
Water	60 gallons.

The chief difficulty in making this wash has been the expense and inconvenience of boiling it for two or three hours, so as to thoroughly dissolve the sulphur. This may

be done either directly over the fire in iron kettles or in barrels by means of a jet of steam. Mr. G. E. Fisher describes his method of preparing this useful wash on a large scale, as follows:—

'There are a great many ways of preparing lime and sulphur wash for spraying, and nearly every one who does it prefers his own way. When large orchards are to be treated, it is not practicable to cook the material to be used, by boiling it in kettles over the fire. In my practice I found that, with the aid of steam from an ordinary threshing engine, this most effective spraying material could be supplied in large quantity perfectly cooked and at a cost of from one cent to one and a half cents per gallon. A 12-horse power boiler will not furnish steam enough to cook 12 barrels at once, without extra heavy firing, and, with ordinary firing, such a boiler will not properly run more than 8 or 9 barrels, which will cook probably about 1,200 gallons of spraying material in 10 hours. The greatest drain upon the steam is in starting, when the water is all cold, and, to expedite matters and get some of the barrels under weigh, I found considerable advantage in starting about one third of them. We fill four barrels one-quarter full and then turn on the steam. With steam at from 80 to 100 lbs. pressure, these will be boiling in five minutes, when the steam is turned off these and on to four more barrels, and all the lime and sulphur are put into the first four as quickly as possible without making them boil over. It is best to turn off the steam while the lime is being slaked, as it lessens the danger of making the mixture boil over. When the lime is all slaked, the steam is turned on again and the mixture is left boiling until cooked. When the second four barrels are boiling, the steam is turned on to the third lot as with the first two, always returning the steam to the barrels as soon as the lime is all slaked. Managing in this way, we always had some material ready for use. That which is prepared late in the evening will still be warm enough in the morning, even in cold weather. In order to make up for the loss of liquid from boiling and to gradually fill the barrels to the proper depth, a small stream of cold water was kept dribbling into them at a rate which allowed the barrels to fill in the course of the two or three hours' cooking necessary to reduce the sulphur. In this way the mixture was kept boiling all the time and the necessary amount of liquid was added. For boiling the mixture in the barrels, we have a quarter-inch pipe which reaches down to within four inches of the bottom of each barrel, and each pipe is provided with a stop-cock.'

'When using a kettle, if I have only one, it is filled about one-third full and brought to a boil. The lime and sulphur are then added, and an old tin pail with a small hole in the bottom is hung over the kettle, and cold water dribbling from it into the kettle replaces the water which evaporates with boiling and increases the quantity. When kettles are used, if there are two, one may be used for heating water; for, while the mixture is cooking, cold water should not be added in sufficient quantity to check the boiling. I have generally slaked the lime in the barrels or kettles as it was required, but on some occasions we slaked it in another barrel by throwing boiling water over it and with just as good results. We certainly got our best results where each gallon of the wash contained one pound of lime and half a pound of sulphur, which we cooked from two to three hours. It is true Dr. Forbes got his wonderful results from a less quantity cooked one and a quarter hours. Mr. Pease, the California Scale Inspector, says it must be cooked at least three hours and that more cooking is better. He believes that this wash is of little use unless sufficiently cooked. We had good results and perhaps should be satisfied, but I think we have good reasons for using the larger quantity of material and cooking a long time. In Michigan again they used less material even than Dr. Forbes. A very common proportion in the United States is 40 lbs. of lime, 20 lbs. of sulphur, 15 lbs. of salt, in 50 imperial gallons of water.'

Dr. S. A. Forbes, who has been very successful in fighting the San José Scale, uses the Oregon wash and is quite satisfied with it. Writing at the end of the season of 1903, he says: 'I am still using the ordinary Oregon wash of 15 lbs. of lime, 15 lbs. of sulphur and 1½ lbs. of blue vitriol, dissolving the lime and sulphur by boiling for

about an hour and then adding the blue vitriol, which has been dissolved in hot water, and boiling for 15 or 20 minutes longer.'

Mr. W. H. Owen, who has done a great deal of work against the San José Scale, on Catawba Island, Ohio, and has tried all of the different remedies which have been suggested from time to time, wrote me recently: 'In 1903 the original California formula was somewhat modified. The quantities of the new formula being lime 15 lbs., sulphur 15 lbs. and salt 15 lbs. to the 50 gallons of water, and this gave equally good results with the old formula. The Oregon wash of 15 lbs. of lime, 15 lbs. of sulphur and 1¼ lbs. of blue vitriol, is what I used during the past season, and I cannot expect to find anything that will do better work than this, both on the San José Scale and the Leaf Curl. When properly made it surely is a perfect insecticide and fungicide. Too much stress cannot be laid upon proper making; for I believe that failure in obtaining satisfactory results can in most cases be traced to careless making.'

The lime-sulphur-and-salt wash, as made in the old method by boiling for a long time, is very fatal to scales, and many other kinds of insects, and there has been a constant effort made to see if the long boiling cannot be avoided. The point aimed at is to dissolve the sulphur thoroughly by means of the lime and heat, and to form a double sulphide of lime. There is an excess of lime in all the formulas used, but this is in no way detrimental. The mixture, however, is not a pleasant one to use, being caustic if it gets on the bare flesh, and is very destructive to clothes of workmen using it. For this reason old clothes should be worn and the hands should be protected with gloves. It must only be used as a winter wash, for if of sufficient strength to destroy the scale, it would injure foliage as well as sensitive stock in autumn before the buds are dormant; but, when buds are quite dormant, it may be used upon all fruit trees and other hard-wooded plants liable to infestation by the San José Scale. Its effectiveness has been proved by several, and one instance which has been seen by many of our Ontario fruit growers, is the case of some plum and peach trees in the orchard of Mr. W. W. Hilborn, at Leamington, Ont. In the spring of 1903, Mr. Hilborn found that a small block of trees was badly infested with the scale. He at once procured a plant for making the lime and sulphur wash and sprayed the trees thoroughly. These trees were examined by me with great care on November 25 last, and I could not find a single living scale. All experimenters recommend that this wash should be applied while it is hot; but, as a matter of fact, this is seldom done in practice, although those who have used hot or warm wash will notice how much more convenient it is to spray when in this condition, and it certainly is more effective in killing the scale.

A simple formula for making this wash in small quantities is 1 lb. lime, ½ lb. sulphur, and 3 gallons of water.

THE NEW LIME-SULPHUR-SODA WASH.

The chief difficulty in making the wash has been the expense and inconvenience of boiling it for such a long time, to thoroughly dissolve the sulphur, and several of our fruit growers have inquired for information concerning some experiments which have been mentioned in the agricultural press and which were undertaken to dissolve the sulphur with caustic alkali and lime, instead of the troublesome and lengthy boiling. These experiments originated with Professors Victor Lowe and P. H. Parrott at the New York Agricultural Experiment Station, Geneva, N.Y., as set forth in the Station Bulletin No. 228, 1902, and consisted of dissolving the sulphur by means of caustic soda or caustic potash in addition to the lime. In making the wash, 40 lbs. lime were slaked in hot water, using only enough water to make it boil rapidly, and while slaking 20 lbs. of ground sulphur, which has been made into a thin paste, is added and thoroughly mixed with the slaking lime. Five pounds of caustic soda in solution is then poured in with more water as needed, and the whole is stirred thoroughly. As soon as chemical action has ceased, hot water is added to make the wash

up to 60 gallons, and the mixture is then ready for immediate use. In making the above wash, it was found that to secure the proper chemical action the quantity could not be reduced lower than: lime 4 lbs., sulphur 2 lbs., and caustic soda (the ordinary concentrated lye of commerce) ½ lb., water 6 gallons. The rule is to use one-quarter of a pound of caustic soda, or potash, to each pound of sulphur. With the exception of heating the water, the whole of the cooking of this wash can be done in a half barrel, and takes from ten to twenty minutes. From the ease with which this wash can be made and from the fact that Mr. Parrott tells me that, although 'the results upon the scale differed with different lots of the mixture, some of the applications were entirely satisfactory,' I believe it is well that several people should try this method of manufacture. The trouble of making the lime-sulphur-and-salt wash has certainly prevented the use of such a valuable mixture to a large extent. I regret to say that my own work with it did not begin soon enough for me to report upon it now. I can merely say that the lime and caustic potash do dissolve the sulphur and that the appearance of the wash is what it ought to be.

Mr. F. T. Shutt, the chemist of the Dominion Experimental Farms, has kindly carried out some test preparations by this convenient new method of making the wash and has handed me the following resumé of his work:—

ON A NEWLY-PROPOSED METHOD OF PREPARING THE LIME-SULPHUR WASH.

(By Frank T. Shutt, M.A., F.I.C., F.R.S.C.)

In the report of the Division of Chemistry of the Experimental Farms for 1902, the results of a series of experiments in the preparation of the lime, sulphur and salt wash by boiling, are given. Since the appearance of that report a method has been proposed by the New York (Geneva) Experiment Station, which obviates the necessity of boiling—the chief drawback to the more common use of this valuable remedy. The modification consists in the addition, at a certain stage in the preparation, of strong lye, such as Babbitt's or Gillett's. The proportions and preparation as given in Bulletin No. 228 of the above named Experiment Station are as follows:—

Lime (unslaked)......	40 lbs.
Sulphur (ground)......	20 "
Lye, concentrated......	5 to 10 "
Water......	60 gallons.

'In the preparation of the mixture the lime was slaked, preferably with hot water, and while it was slaking vigorously, the sulphur, which had been made into a thin paste, was added and thoroughly mixed with the slaking lime. The caustic soda was then added, with water as needed, and the whole stirred thoroughly. As soon as the chemical action has ceased, the required amount of water, preferably hot water, is added, and the mixture is ready for use.'

It will be noticed that in this process there is no boiling and no salt, an ingredient in the old formula which apparently had no direct value, but was useful in raising the boiling point of the mixture, thus ensuring a more complete union of the sulphur and lime.

At the request of the Entomologist (Dr. Fletcher), we made several trial preparations in the laboratory and found that the proposed method is quite workable and simple, and yields a product in which there is *very little uncombined sulphur*. This latter is an essential point, as undoubtedly it is the sulphur compounds that give this wash its great value for destroying the scale. It is necessary to this end that the sulphur be added (in a thin paste) while the lime is still actively slaking—for which purpose care should be taken to use only a sufficiency of water—and the mass stirred

vigorously. As soon as the sulphur paste is poured on to the slaking lime, add the solution of lye, with such further quantities of water as may be necessary, stirring and mixing, until all bubbling ceases. There is now an orange-yellow, pasty, homogeneous mass, which can be diluted to the requisite volume, either at once or at any subsequent time, if kept out of contact with the air.

As far as one can judge from what might be called the chemical or physical point of view, this wash should prove equally effective with that prepared by boiling.

F. T. S.

In an excellent bulletin just issued by Prof. J. B. Smith, of New Jersey, entitled 'Insecticides and their use,' this lime, sulphur and soda wash is mentioned and some valuable suggestions are made. Prof. Smith says: 'This wash has been found quite effective, but it is not so good as the boiled mixture, and costs a little more.' He also draws attention to the fact that warm water must be used as well as a good quality of stone lime and of caustic soda, and further that it must be remembered that a can of lye does not equal a pound.* He further states that 'all these combinations of lime and sulphur are more or less unstable and sooner or later the lime settles and the sulphur forms long spicules. When this occurs, the mixture is ineffective in proportion as the sulphur has become separated out. The best boiled combinations become useless in forty-eight hours, and in all cases the wash is most effective just after it is made.'

The above extracts from Prof. Smith's bulletin indicate the importance of using the lime and sulphur washes while fresh; but the statement that 'the best boiled combinations become useless in forty-eight hours,' is probably too sweeping.

A point upon which too much stress cannot be laid is the great importance of washing out thoroughly all pumps and hoses used for spraying caustic or corrosive insectide and fungicide washes.

FOREST AND SHADE TREES

Forest insects and those which attack shade trees in cities, have been, on the whole, less injurious than usual during the past season. There were, however, one or two outbreaks which require mention. The White-marked Tussock-moth has increased very much in the cities of Toronto, Montreal and Kingston, so much so that remedial measures are now urgently needed, or the beautiful shade trees in those cities will suffer irreparably at no distant date. Something has been done in the past by the city authorities to control this insect, but of late years they seem to have relaxed their efforts, and the insect is increasing in numbers. A remarkable outbreak of the Maple Soft Scale (*Pulvinaria innumerabilis*, Rathvon) occurred on shade trees in the cities of London, Woodstock and Hamilton, as well as in other places in south-western Ontario. The well known Fall Webworm (*Hyphantria textor*, Harr.), which for some years has been occurring only in small numbers, during the last season increased sufficiently in most parts of the Dominion to attract general attention. The unsightly webs were very conspicuous in British Columbia and in many places in Ontario and Quebec. The webs of the caterpillars are so easily seen that this insect, if attended to, can be controlled with comparative ease, by spraying the trees with poisonous applications or by cutting off the webs, each of which contains a whole colony of

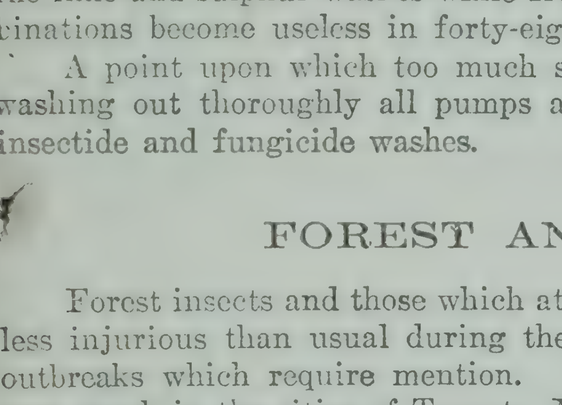

Fig. 20.—The Fall Webworm: *a*, caterpillar; *b*, pupa; *c*, moth.

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*The contents of several cans of concentrated lye which were examined here in no case quite came up to 1 lb. avoirdupois.

caterpillars. This must, however, be done before the caterpillars reach full growth, or the work is useless. I have known of one instance where a municipal body with all good intentions employed a man to cut out all of the webs of this insect and those of the Tent Caterpillar in winter time, under the supposition that by this means they were controlling those enemies. It is true the trees were more sightly when these nests had been removed; but the operation in no way affected the abundance of the species the following summer, because the caterpillars only live in the nests until nearing full growth, when they leave them and pupate or build their cocoons in other places. The Tent Caterpillars pass the winter inside the eggs, which may be found on trees, and the Fall Webworms as pupæ buried in the ground. Prof. Lochhead reports 'that the Fall Webworm was very abundant in western Ontario late in summer, not only on shade trees, but on many kinds of fruit trees, and unquestionably did considerable harm. On account of the scarcity of labour in rural sections, few attempts were made to get rid of the ugly webs filled with caterpillars. Unless parasites thin them out very much, there is every likelihood that the Fall Webworms will be very numerous next season.' The Negundo Plant-louse *(Chaitophorus negundinis,* Thomas) was observed as injuriously abundant in Winnipeg, Regina and Calgary, the shade trees, which are largely Ash-leaved Maples, being much disfigured by the copious deposit of honey-dew on the leaves, and the Sooty Fungus which grows upon it. These trees attracted swarms of flies during the daytime and of moths at night. The remedy recommended for clearing these trees was to spray them with kerosene emulsion, 1 to 9, or whale-oil soap, 1 pound in 6 gallons of water, with or without tobacco. The tobacco, however, adds considerably to the killing value of the wash. The Spruce Gall-louse *(Chermes abietis,* L.) has spread widely through the Dominion, and has been the cause of a good deal of injury to spruce trees. In the forest, nothing can be done to check the spread of the insect; but in the case of ornamental trees, good results have followed spraying with a tobacco and soap wash. The Fall Cankerworm was very abundant and destructive in the woods around Ottawa early last spring. The caterpillars were not quite full grown on June 12 last, when the first heavy rains came, which broke the exceptional drought which up to that time had prevailed throughout eastern Ontario. Previous to that they had been literally swarming in many woods along the Ottawa river. After the rains they suddenly disappeared, and the total absence of both male and female moths in the woods in autumn was noticed by many. It is possible, therefore, that there will not be a recurrence of this attack for some time. The Birch Skeletonizer *(Bucculatrix canadensisella,* Cham.) did some harm to birch trees of all kinds again last year in eastern Ontario. The attack, however, was not nearly so severe as in the two previous years, nor was its work supplemented by that of the large aphis, *Callipterus mucidus,* Fitch, and the small green leaf-hopper, *Empoasca smaragdula,* Fall., which for the last two years have perhaps done as much harm to trees on the Central Experimental Farm as was done by the *Bucculatrix* caterpillars. On my return to Ottawa on August 21 last I found the birch trees on the ornamental grounds of the Central Experimental Farm attacked in some places by the Birch Skeletonizer to such an extent that some trees looked about half clothed with foliage. These were at once sprayed with a whale-oil soap and tobacco wash, which was quite effective, and no further injury was done. Should this insect again occur, trees should be examined in July and early August, and, if the small caterpillars or the round white pseudo-cocoons in which the caterpillars pass their moults are seen in numbers, the trees should at once be sprayed before the foliage is injured to a conspicuous extent.

THE WHITE-MARKED TUSSOCK-MOTH

[*Hemerocampa (Orgyia) leucostigma*, S. and A.]

Attack.—Slender, sparsely hairy caterpillars, from one and a quarter to one and a half inches in length, blackish above and paler beneath, with two bright yellow stripes along the back, most conspicuous towards the end of the body. There are four short brush-like tufts of whitish hairs on segments 5, 6, 7 and 8. The head chestnut red; a large patch on segment 2, and two small glandular spots on segments 10 and 11, bright vermilion red. From each side of segment 2, close behind the head, are long plume-like tufts of black, barbed and knobbed hairs; a similar plume ornaments segment 12. When full grown these caterpillars have a decidedly handsome appearance, which is well represented in the accompanying figure. The male moth measures about an inch and a quarter across the wings, and is marked as shown in Fig. 22. The colour is gray and the wings are crossed by wavy bands. The base of the fore-wings bears a dark patch, and there is another of smaller size towards the tip. The popular name is given to this moth from the presence of a small white spot near the outer hind angle of the fore-wings. The female is a large-bodied wingless pale gray creature, with only rudiments of wings. On emerging from the cocoon she crawls on to it and seldom moves from it. After pairing, she lays a mass of eggs, from four to five hundred in number, generally on the outside of her cocoon, and then dies there. These eggs are covered over as laid with a white frothy fluid, which dries over the eggs and protects them through the winter. There is in Canada only one annual brood of this insect. The eggs may be found during the winter on the trunks of trees upon which the caterpillars had fed the previous season. The young caterpillars emerge from the eggs at the end of May or early in June, and soon crawl up and distribute themselves throughout the foliage of the trees, feeding at first beneath the leaves, and when disturbed letting themselves down by a slender silken thread. By the middle of July the caterpillars have for the most part become full grown and are preparing to spin their cocoons. As they increase in size, they become very ravenous and strip entire trees, eating the cellular tissues between the veins of the horse chestnut leaves, which appears to be the favourite food plant, and producing a characteristic injury, which is easily recognized. These caterpillars have a habit of wandering from branch to branch and from tree to tree, which has given rise to the practice of banding trees with strips of cotton batting. This gives a very untidy appearance to streets and does not do very much good, certainly not enough to atone for the unsightly appearance of the trees. The most effective remedies for the White-marked Tussock-moth are (1) the collection of the conspicuous egg masses from the trunks in winter or before they hatch in spring. This may be easily done by means of a small wire brush on the end of a long pole which will reach up among the larger branches of the trees. Such a brush as this was devised by the late Alderman Hallam, of Toronto, and used to good effect on the city shade trees during a previous outbreak of this insect. (2) Undoubtedly the best remedy is the systematic spraying

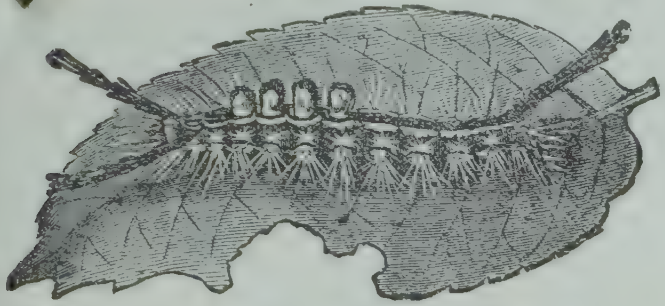

Fig. 21.—The White-marked Tussock-moth: caterpillar.

Fig. 22.—The White-marked Tussock-moth: male moth.

Fig. 23.—The White-marked Tussock-moth: female moth.

of shade trees with some arsenical poison as soon as the young caterpillars hatch from the egg, or as soon afterwards as possible. This work, if properly done, will destroy every caterpillar and render unnecessary the collection of the eggs in winter and the use of unsightly tree protectors, bandages of cotton batting, or sticky substances, all of which are more costly and objectionable. It might be well to point out that, when municipal bodies adopt the plan of collecting the cocoons in winter, it would be well to place these for a time in some place where any parasites which might be passing the winter in the cocoons could emerge and escape, but where the young caterpillars upon emerging would find it impossible to gain access to any trees. This might be done by putting them in an upper room of some building from which the parasites could fly out of the windows, but from which the young caterpillars could not crawl to trees which would serve them as food. Deprived of food, they will soon starve after leaving the egg.

THE APIARY

The Apiary, as in the past, has been under the management of Mr. John Fixter, the farm foreman, whose report I append herewith. The same experiments which have been carried on for some years have most of them been repeated on account of the large amount of interest which has been evinced in the subject by correspondents and visitors to the Central Experimental Farm. The services of Mr. Fixter have been asked for at a great many meetings of bee-keepers, and, whenever his duties at the Central Experimental Farm would permit of it, he has attended these meetings and given addresses.

REPORT OF MR. JOHN FIXTER.

The season of 1903 has been a poor one in the Ottawa valley, but in the greater part of western Ontario the crop has been excellent both as to quality and quantity; parts of the province of Quebec also report good crops, principally where Bokhara clover grows extensively; also in districts which had sufficient moisture in the spring.

The season opened very early; the colonies were set out on their summer stands on March 21. The temperature on that date being 48; and the day bright and mild was most favourable for the cleansing flight of the bees. Then followed several days of cool windy dull weather, which kept the bees confined to their hives; this continued all the rest of March. April was also very unfavourable, being cool and windy. During the greater part of the latter month there was only about three-quarters of an inch of rain, all growth and bloom being thus kept back. May set in warmer; the bees gathered pollen freely, and built up fairly well. It was necessary to feed the bees during May to keep up brood rearing. Only about a quarter of an inch of rain fell during May, and up to June 8 the land was so dry and hard that no clover of any account came in bloom. After June 8, abundance of rain fell, many flowers appeared, and the small amount of surplus honey was gathered after that date. Swarming was light owing to the poor season. There being no fall honey flow from any source all supers were removed on August 26.

On September 1 all colonies were weighed; any that did not weigh 50 pounds and over were fed. When feeding, care must be taken not to feed weak swarms, but the strong ones; then, when these have filled the frames these latter should be given to the weak colonies: otherwise the weak colonies are liable to get robbed. A much better plan of bringing colonies up to the required weight is, in the extracting season, to save some of the well-sealed combs to fill up the light colonies with them. There is then very little danger of their being robbed.

On November 24 all colonies were weighed and found to be in good condition. They were then put into their winter quarters.

Returns from the Experimental Farm apiary averaged 23 lbs. per colony.

Meetings were attended during 1903. The Ontario Bee Keepers' Association at Barrie and Trenton; also farmers' and beekeepers' joint meetings at the following places: Manotick, North Gower, Stittsville, Richmond, Malakoff, Lanark, Wellman's Corners, Bell's Corners, Jockville, Carp, Kinburn, Smith's Falls, Leonard, Metcalf, Balderson and Innisville, in Ontario; Grenville, Lachute, St. Andrews, Como, Buckingham and Templeton in Quebec.

INSULATING HIVES FOR OUTSIDE WINTERING.

Two colonies of equal strength with good laying queens in Langstroth hives were taken for this experiment. The hives were insulated against the winter cold by air cushions in the following manner:—

Slats 1 inch thick are nailed at intervals all round the hive, on these is packed one layer of thick brown building paper and then a layer of oiled paper, which increases the durability and keeps out vermin. In order to provide extra protection to the hive, a box six inches wider and six inches longer was placed over it with an opening cut at the entrance 1 inch by 2 inches, all other openings being closed.

The wooden cover of each hive was removed and replaced with a chaff cushion 3 inches thick, the latter placed on the propolis quilt, and lapping over the sides of the hive; two layers of paper were then placed on the top of the cushion and a second cushion added, with the top of the outside box over it. The bees were put into winter quarters on November 18, 1902. No sound could be heard from those colonies all winter, up to March 10, when a slight hum was perceptible. On March 20, 1903, the first bees made their appearance; there were many dead bees at the entrance of the hives. On March 21, the outside cases were removed, leaving the paper and one chaff cushion on during the cold spring. Upon examination one colony was found to be in fairly good condition, the other very poor, with many dead bees on the bottom board. A few days afterward the latter was found to be deserted. The frames in both cases were all dry and clean and had abundance of honey to carry them through from November to the clover bloom. Weight, when put into winter quarters, 53½ lbs. each; in spring, 37½ pounds each. Owing to the cool, backward spring, the surviving colony did not build up until May 1, when warmer weather set in; the bees at once began gathering pollen and built up very rapidly. The colony was in excellent condition for a honey flow, but during May and the early part of June the weather was very dry and warm, keeping all bloom backward; the bees, therefore, made but little surplus honey.

This experiment is to be tried again this winter.

EXPERIMENTS TO TEST WHETHER DAMPNESS OR MOISTURE WOULD BE INJURIOUS TO BEES IN THEIR WINTER QUARTERS.

Three colonies were selected for this experiment, all of about equal strength, and all in Langstroth hives, weighing on an average 55½ pounds each. The wooden covers were removed from the hives and replaced with propolis quilts; the bottom of each hive was loosened from the brood chamber and a block two inches square was placed at each corner between the bottom board and the brood chamber, insuring free ventilation from the bottom of each hive. Four pails of water were then put on a table in such a way that the three hives were set resting on the edge of the pails, allowing the full surface of water to be exposed. The cellar was kept at a very even temperature of 42 to 48 degrees, and was well ventilated during the whole winter. The bees could be seen hanging below this frame in a quiet cluster, and there were very few dead bees on the bottom board, and no signs of dysentery.

On March 22, the day being fine, the colonies were removed to the bee yard, where all began flying at once. Average weight of the three colonies when set on their summer stands, 43¼ pounds each. From March 22 to May 1, the weather, although bright, was cool and windy, and very little flying took place. After May 1, the weather became considerably warmer, and the bees began building up rapidly. They were in excellent condition by May 24.

EXPERIMENT IN FEEDING BEES IN THEIR WINTER QUARTERS.

Many letters have been received from people who have only a few colonies of bees, stating that when carrying their bees into winter quarters they had discovered there did not seem to be a sufficient store of honey in the hive to carry the bees through the winter. To gain information as to the best method of overcoming this difficulty the following experiment was tried with six strong colonies of bees:—

Four frames of sealed honey were taken from each of the six hives, leaving the cluster on the four remaining frames. The four frames were left in the centre of the hive with a division board at each side, and some light packing placed between the division boards and the sides of the hives. The wooden covers were removed and replaced by large propolis quilts made of heavy canvas. Over the top of the propolis quilt extra packing was added to keep in the heat, absorb moisture and prevent draughts or upward ventilation. The bottom boards were left on as they came from the bee yard, leaving the entrance wide open. The experiment was made as follows:—

1. Two colonies received maple sugar of the best quality.
2. Two colonies received partly filled sections of honey.
3. Two colonies received candied honey and sugar.

Each colony when put on this test, weighed 31 pounds, and each was given 5 pounds of its respective food to start with. The experiment lasted from November 18, 1902, to March 22, 1903. The two colonies fed on maple sugar consumed 11½ pounds each, they were examined every two weeks and water added to the sugar through holes in the tops of the cakes, keeping it soft and moist.

The two colonies fed on partly filled sections of honey, consumed during the same time 14¾ pounds each. There was for several reasons considerable waste in this test; consequently if partly filled sections could be sold even at a reduced price it would be advisable to sell them instead of feeding back.

The two colonies that were given candied honey and sugar consumed 10¾ pounds each. The candied honey was moistened from time to time, which made it easier for the bees to suck it up. Candied honey is made as follows: Take good thick clover honey, and heat (not boil) it until it becomes very thin; then stir in it fine granulated sugar. When the honey has dissolved the sugar, pour it into another vessel, and, when it has cooled sufficiently, thoroughly knead it with the hands. The kneading makes it more pliable and soft, so that it can take up more sugar. The kneading operation, with the adding of fine sugar, should be continued until the dough is so stiff as to be quite hard to work. It should then be allowed to stand for a day or two, and, if at the end of that time it is so soft as to run or to be sticky, a little more sugar should be kneaded in, so that it may be cut into cakes of a convenient size. These cakes are to be placed on top of the frames in such a way that the bees can get at them easily.

The colonies in all the three tests came through in excellent condition. Any one of the three methods may be safely followed, but I would strongly recommend examining and weighing all colonies the first week in September. At that time every colony should have a good laying queen, and should weigh over 50 pounds. In seasons when there is no autumn flow of honey, all colonies in Langstroth hives weighing less than 50 pounds in September should be fed up to that weight at least. The best method for getting colonies up to the required weight is, when the extracting takes place, to save several full well-sealed combs, then remove some of the light ones out of the hives and replace them with the heavier full frames. If no honey is available, feed sugar

syrup. This plan is rather a tedious one and great care must be taken not to daub the hives or appliances, as robbing at this season of the year is very easily started and very hard to stop.

If the colonies that are short of stores are weak or feeble in number of bees, they should then be fed with syrup. In order to provide for them, feed the strongest colonies you have, for instance, by putting in their hives extra frames and feeding the syrup in a Miller feeder. A good strong colony will take down 10 to 15 pounds in a warm night. Continue the feeding until you have sufficient frames well sealed to make up the required weight. The full frames are then removed and given to the weak colonies that are short of stores; by this method there will be very much less danger of robbing, as the strong colonies are well able to look after themselves.

Sugar syrup may be made as follows: Use the best grade of granulated sugar, two parts to one of water by weight. The water should first be brought to a boil, then the pan or vessel set back on the stove so that the boiling will not continue but the water be kept sufficiently hot to dissolve all the sugar. The sugar should be poured in slowly and thoroughly stirred until all is dissolved. The syrup should then be fed in a lukewarm condition..

Foul Brood.

Much attention has been drawn of late to this most destructive disease of bees, which affects particularly the larvæ or brood, causing them to die, mostly at the age of six to nine days. The disease is spread by bees feeding their larvæ with infected food, and is carried to new colonies by bees robbing diseased colonies. It is thought advisable to publish in this report the McEvoy method of detecting the disease and stamping it out when found in an apiary. With reference to this method of treatment of foul brood we have much pleasure in quoting the following from Wisconsin Bee-keeping, Bulletin No. 2, 1902, by N. E. France, State Inspector of Apiaries.

'In Wisconsin I have tried many methods of treatment and cured some cases with each method, but the one that never fails, if carefully followed, and that commends itself, is the McEvoy treatment. It has cured foul brood by the wholesale, thousands of cases.' Mr. McEvoy decribes his method as follows :—

The McEvoy Treatment.

How to detect foul brood.—When any dead brood is noticed in a hive, a sure way to ascertain whether the cause of death is the disease known as foul brood, is to put the head of a pin into a cell of a comb and draw it out; if the matter contained in the cell adheres to the pin's head and can be stretched about three-fourths of an inch, it is undoubtedly a case of foul brood. But every bee-keeper should be able to recognize the disease at a glance without having to use a pin, as above said; he should learn to know the stain mark of foul brood when he sees it. The manner of proceeding to examine an apiary in which foul brood is suspected, is as follows:

Before opening any of the hives give every hive in the vicinity a little smoke at the entrance. This will check the bees for a time from coming from other colonies to disturb you when you have a hive open to examine the combs. After taking a comb out to examine it, turn your back to the sun, and, holding the comb in a slanting position, let the light fall on the lower side and bottom of the cells; look there for the dark scales left in the cells and formed from the dried up, decayed bodies of the dead larvæ. Another sign of the presence of foul brood is that several of the cappings have a small hole in them, but this also appears in the case of cells containing brood killed by other causes than this disease.

[Mr. Charles O. Jones, of Missisquoi, Que., describes the symptoms of foul brood as follows in the Montreal 'Weekly Star' :—

'Of the diseases affecting the brood, the most serious is foul brood, which has appeared in some localities in Ontario in a virulent form, but is being successfully

combated. The symptoms of this disease are not easily mistaken by one who is at all familiar with it. The brood hatches unevenly and the cappings have a shrunken appearance, and many of them are perforated as if the bees had begun uncapping the brood. The dead brood will be found adhering to the side (lower side) of the cell, and of a brownish colour. On inserting a small stick, the decomposed brood will adhere, and when withdrawn three-fourths of an inch, will still cling to the stick. Beside this "ropiness," the dead brood has a distinct odour very much like old glue. If the disease has developed sufficiently, this odour may be detected on removing the covering from the bees. These two last symptoms are peculiar to foul brood, and if present, are considered a certain indication of infection.']

HOW TO CURE INFECTED APIARIES.

Every infected apiary should be treated according to the condition in which it is found, and at the same time not only to stamp out the disease, but also so as to induce considerable increase in the colonies, and end by having every colony in first-class condition. I may therefore first explain how I proceed. The best time for this work is while the bees are gathering freely during the honey season.

For this, taking two hives at a time, I shake off the bees from them with one of the queens, and give them a clean hive with foundation starters, leaving in the two original hives one queen and only about a quart of bees to take care of the brood still unhatched in those two hives. I now remove the bottom of one hive and the top of the other, and place the first on the top of the second, so that the bees may unite and, as the young bees hatch out, form one strong colony. By the time that most of the brood is hatched I have from the two colonies, when united, one large swarm of young vigorous bees. This swarm must then be shaken into a fresh clean hive with foundation starters.

I have now two first-class colonies, each containing a queen, one from the bees first shaken out of the two original infected hives, and another from the brood left i the original hives with a queen and a small number of bees to take care of it. Both these colonies must now be treated to destroy the disease. All handling of diseased colonies, especially during warm days should be done in the evening, when no bees are flying. This will prevent robbing, and also will prevent bees from diseased colonies mixing with those from sound colonies, going into their hives with them. Again, by doing the work in the evening, it gives bees which have been treated a chance to settle and quiet down before the morning.

[Mr. Jones, of Missisquoi, explains the same treatment as follows:—

'The cure, although simple, requires great care to carry it out successfully. A clean hive containing frames with starters of foundation, should be placed on the old stand after removing the affected hive. Remove the combs from the affected colony, and shake the bees in front of the clean hive into which they will run. This should be done at nightfall, when the bees are all at home, and then there will be no danger of robbers getting at any of the tainted honey. Leave the bees in the new hive for at least four or five days, by which time they will have used all the honey they carried with them in comb-building, when you can remove the starters to melt into wax, replacing them with frames filled with sheets of foundation, and your cure is effected. I would advise burning the combs and honey removed from the hive and thoroughly disinfecting the hive by scalding before using again.

'Some authorities advocate caging the queen for ten days or so, to prevent brood rearing until all danger of infection has passed, but I consider this only as an extreme precautionary measure; in fact, hardly necessary.']

Treatment during the Honey Season.—When the bees are gathering freely, remove the combs from the hive in the evening, replacing them by frames with comb foundation starters, as said before; then shake the bees from the combs into a clean hive and let them build comb for four days. By that time they will have made the starters into combs, and will have stored in these the infected honey which they brought from the

old combs. On the fourth day, in the evening, replace those combs containing the infected honey with full sheets of fresh comb foundation, and the cure will thus be complete. By this method of treatment, all the infected honey is removed before the full sheets of foundation are used.

When only a few cells are found with foul brood, after shaking off the bees for treatment, two hives may be filled with the combs containing the brood; then place these two hives on top of each other, as explained before, keeping them shaded from the sun until most of the brood is hatched. Then, in the evening, shake the bees from both hives into another single hive and give them frames with comb foundation starters. Let them build comb for four days, as above said, after which, in the evening, take out the new comb and give the bees comb foundation to work out to complete the cure. If the diseased colonies are weak in bees, the bees of two, three or four should be put together, so as to have a strong colony to start the cure with, as it does not pay to spend time over weak colonies.

When bees are not gathering honey.—An infected apiary can be cured of foul brood by removing the infected combs in the evenings and giving the bees frames with comb foundation starters on. Then, also in the evenings, feed the bees plenty of sugar syrup; they will draw out the foundation and store the infected honey which they took with them from the old combs. On the fourth evening, replace the new combs made out of the starters by frames with full sheets of comb foundation, and feed plenty of sugar syrup every evening until all the colonies are in first-class order. The sugar syrup should be made of granulated sugar, using one pound of water to every two pounds of sugar, and bringing it to a boil.

Treatment after all honey gathering is over.—When the disease is discovered in a few good colonies after the honey season is finished, the best plan is to leave them until an evening in October. Then take every comb out of the diseased colonies, replacing them by six combs of all-sealed or capped stores from sound colonies. Place a division board on either side of these all-capped combs. These colonies will thus be in perfect condition for wintering, and the disease will at the same time be stamped out; for, as there are no empty cells, the bees must have kept the infected honey which they took out of the old combs, until it was consumed, as they could not find a place in the all-capped combs to put it.

If there is a scarcity of all-capped combs from the sound colonies, as many as are required can be secured by putting Miller feeders on sound colonies in the evenings in September and feeding the bees all the sugar syrup they can be made to take; then, in October, each of these fed colonies can spare the two outside combs, which will be perfectly capped all over down to the bottom of the frames. These all-capped combs will provide plenty of good stores to carry out this autumn method of treatment.

All the old infested brood combs which have been removed from the hives, must be burned or made into wax, as well as all the combs made on the starters by the bees during the four days of the treatment.

As to the infected honey, I have always been opposed to having it treated and then fed to bees, for fear that the treatment may not be thorough enough. My recommendation is to bury it in the ground, as well as all the refuse from the honey extracted. This applies also, of course, to the honey stored up in the combs during the four days of the treatment.—W. McEvoy.

Treatment of the Hives and Frames.—In Mr. McEvoy's treatment of foul brood, there appears to be a danger that the hives themselves in some of their parts might be tainted with germs of the disease. We would, therefore, strongly recommend to disinfect the hives and the frames that have contained foul brood, by a thorough scalding. This operation is very simple; and, in view of the great losses that have been occasioned by foul brood, it is important to neglect no means to secure success in stamping out the infection.

John Fixter.

DIVISION OF BOTANY

FODDER CROPS.

The season of 1903 was not a good one for the production of heavy crops of fodder of any kind. In the East an exceptionally prolonged drought prevented grass and clover from starting well, and although, when rains came, these crops picked up in a surprising manner, still the yields were below the average in most places. A cool, damp autumn prevented corn from maturing and made it difficult to cure all hay crops.

Among various fodder plants which have been grown on the experimental plots at the Central Experimental Farm, one which has lately received much attention is Sainfoin *(Onobrychis sativa,* DC.). This beautiful plant, which may be known at once by its pinnate leaves and large cones of rose pink flowers on slender stems, is allied to the clovers, and, as a rule, is spoken of as a clover in the same way as Alfalfa or Lucerne is. It was noticed on the experimental plots that the flowers of this plant were extremely attractive to bees, and it is also a producer of good fodder, suitable for all stock. It is not as heavy a cropper as Alfalfa, but like that is a persistent perennial which roots deeply and in localities which suit it, produces heavy crops of hay.

The following notes on the cultivation of this plant have been prepared mainly by Mr. John Fixter, the farm foreman at the Central Experimental Farm.

SAINFOIN.

This clover has attracted much attention on the Central Experimental Farm, both as a fodder plant and also as a honey producer. In its cultivation and manner of growth it resembles alfalfa, but it is slightly finer and grows thicker in the bottom, having a more decided stooling habit, which makes it better for pasture. It is specially liked by sheep. The soil best suited to the growth of this plant seems to be a deep rather dry loam, containing a fair proportion of lime with good natural drainage. It will do well upon almost any soil that is well drained, provided it gets a good start. Heavy clay and light sandy soils both produce excellent crops of sainfoin, but on the latter it naturally requires generous manuring. It should never be sown on land likely to be covered with water at any season of the year. The amount of seed sown under ordinary conditions is about 20 lbs. per acre. Great care should be taken to secure new and plump seed; the hulled seed is preferable when it can be obtained, as it is easier to sow and germinates more quickly. A good seed bed is of great importance, and one of the best methods for preparing this, and also at the same time clearing the land of weeds such as quack grass and thistles, is to cultivate it with a firm-footed cultivator. If the field has been in meadow or grain, do not plough, but simply cultivate and harrow; first cultivate as shallow as possible, then pass the heavy iron harrows at a good sharp walk across the first cultivating. This operation will break up the sod or stubble very fine and leave it on the surface to dry out. The second cultivating should be in the opposite direction to the first, and likewise the harrowing. By this operation two-thirds of the sod will be loosened from its roots. It usually requires about four cultivations and four harrowings to make a perfect job. All this work must be done on fine sunny days, and the sooner after harvest the better. The cul-

tivating and harrowing must be gauged by the growth. If possible, every leaf must be cut off and kept out of sight, and all vegetation brought to the surface to be dried by the sun. This dead but valuable material may, during the autumn, be ploughed under to decay and add to the fertility of the soil. By the next spring this land should be in perfect condition for sowing. The best time to sow is as soon as the ground can be got ready in spring; the seed will then germinate quickly. As sainfoin is a quick-growing and deep-rooting plant, the roots keep going down into the moist earth so that dry weather will not have much effect upon it. If sown with a nurse crop, oats, wheat or barley may be used, but the latter is preferable, as it can be harvested earliest. Not more than half the ordinary amount of grain should be sown per acre with this clover, and better results are usually obtained by sowing it alone. It may be sown broadcast, then harrowed in and rolled so as to render the surface smooth, or it may be sown with the ordinary grain drill with grass seed attachment. The seed should be dropped in front of the drill and the land should afterwards be rolled. The small seeds will thus be covered, and, the surface being smooth, the young plants will come up quickly and regularly. For this crop land may be prepared by late summer-fallowing, or, what is even better, the seeding may follow a hoed crop; but, whatever the preparation of the land, it must be clean, and, as the seeds are small, it is essential to have it in a good state of tilth.

This plant has been grown on the experimental plots at the Central Experimental Farm for several years. The oldest plot now living has been standing for seven years, a second plot for two years, and the third plot was sown in the spring of 1903. The plot which has been growing for seven years is now thin and will soon be ploughed down. It would probably be the most economical plan to plough down this clover after three years and resow. As is well known, clovers of all kinds are the most valuable plants which can be grown and ploughed down as fertilizers, and the benefit of ploughing under this clover would more than pay for the resowing.

The Botanist's records of the experimental plots show that Sainfoin sown May 14, came into bloom on August 12 of the same year, was cut for hay on August 25, and gave a yield per acre of 1 ton 1,700 lbs. of cured hay. The second growth of the first year should be allowed to stand over for the winter as a protection to the roots, In the second year the plants came into bloom on June 1st and lasted up till the 24th of that month, when the plot was cut for hay. These dates might have been extended, had the plants been grown merely for honey; but, as they were at that time in the best condition for hay, they were cut for that purpose. If the crop had been left to stand longer, the hay would have been too woody. The yield of this first cutting was 2 tons 200 lbs. of cured hay per acre—a rather small crop, due to the excessive drought, which lasted up till June 12. The second bloom was on July 27, and lasted until August 17, when it was again cut for hay, giving 2 tons 1,400 lbs. of cured hay, or a total yield for the year of 4 tons 1,600 lbs. A third crop, which will provide some pasture, is allowed to remain on the ground for the winter, or in very favourable seasons might be again cut before winter, although this is not advisable.

From what we have seen of this clover, it is believed that farmers and bee-keepers would find it profitable to grow it.

HAY AND PASTURE MIXTURES.

In the last annual report the results of growing several mixtures of grasses and clovers were published. These experiments were again observed during the past season, and the yields given herewith are from the same plots which were sown in 1901. Last season should have been the large crop from these plots; but, unfortunately, the yields were very much lessened by the exceptionally dry weather which prevailed in spring at the time when meadows most require copious moisture. The yields for 1903 are given, together with those of the previous year, for comparison. It will be seen that several of these mixtures give heavy yields of excellent hay, and all of them are worthy of the consideration of the farmers of Canada.

Number.	Mixtures Sown May 4, 1901.				Cured Hay, per Acre.							
					1903.				Total.			
	Grasses.		Clovers.		July 14.		Sept. 30.		1903.		1902.	
		Lbs.		Lbs.	Tons.	Lbs.	Tons.	Lbs.	Tons.	Lbs.	Tons.	Lbs.
1	Timothy.......... Meadow Fescue.... Orchard Grass...... Kentucky Blue..... Red Top...........	6 4 2 1 1	Alfalfa. .... Alsike........ ..... Mammoth Red. .... Common Red....... White Dutch.	2 2 1 1 2	2	1,160	1	1,360	4	520	4	40
2	Meadow Fescue.... Timothy. .... Canadian Blue. .... Orchard Grass...... Red Top...........	6 3 2 3 3	Alfalfa. .... Alsike.... .... White Dutch........	4 1 1	2	720	1	840	3	1,560	4	660
3	Timothy. .. .. Awnless Brome..... Orchard Grass......	5 4 2	Alfalfa. .... Alsike...........	6 3	2	1,210	1	1,560	4	770	5	120
4	Meadow Fescue.... Orchard Grass...... Kentucky Blue.....	6 2 1	Common Red....... Alfalfa. .... White Dutch.......	4 3 1	2	640	1	1,680	4	320	5	1,520
5	Timothy.... .... Upright Brome.....	6 4	Alfalfa. .... Mammoth Red.....	6 4	2	1,320	1	1,520	4	840	4	960
6	Timothy...........	10	Common Red.......	6	1	1,680		1,200	2	880	4	76[illegible]
7	Timothy...........	10	Mammoth Red.....	6	1	520		1,000	1	1,520	3	1,200
8	Orchard Grass... ..	18	Alsike..............	5	1	840		1,240	2	080	2	1,200
9	Orchard Grass.....	18	Common Red.......	8	1	1,800		1,800	2	1,600	3	1,280
10	Meadow Fescue....	20	Common Red.......	8	1	1,320		1,360	2	680	3	40
11	Timothy.	12	Mammoth Red	8	2	280		1,120	2	1,400	3	1,760
12	Timothy.	12	Common Red.......	8	2	80		1,840	2	1,920	3	20
13	Timothy. .... Awnless Brome.....	5 10	Common Red....... Mammoth Red......	5 5	1	1,920		1,920	2	1,840	4	300
14	Awnless Brome.....	25	....		1	1,360	....		1	1,360	3	1,020
15	Awnless Brome.....	15	Common Red.......	8	2	40	1	320	3	360	4	760
16	Timothy.	8	Mammoth Red.	8	2	480	1	680	3	1,160	3	340
17	Alfalfa............	15	(weight green, 8 tons 720 lbs.)		3	120	1	1,040	4	1,160	3	1,160

There has been a large correspondence carried on with farmers in all parts of Canada with regard to the best grasses to grow for hay and pasture, and also as to the best crops for late sowing in seasons when drought or other adverse conditions have interfered with the germination or development of corn and other fodder crops. In the drier districts of the West excellent results have been secured from sowing Alfalfa and Brome grass together, 12 to 15 lbs. of the former and 6 of the latter, or mixtures in varying proportions according to the requirements of the growers, of the small grains and some leguminous plant. The mixtures, which have given good satisfaction, are: Tares and oats, a bushel and a half of each, or Peas and oats, in the same proportion; Peas, wheat and oats, one bushel of each; or Peas, wheat and late barley. All of these give heavy crops of excellent hay. A valuable crop which is every day growing in favour, is Fodder Rape. This has been grown with much satisfaction in all parts of Canada. It is best sown alone, two pounds of seed to the acre in drills thirty inches apart, so as to allow of cultivation to destroy weeds and to hold in moisture when the seed has been sown late. Crops of rape are ready for cutting or feeding off in about sixty days after sowing. Two or three crops may be taken before winter sets in.

AUTHOR'S EDITION
FROM ANNUAL REPORT ON EXPERIMENTAL FARMS FOR THE YEAR 1904

CANADA

DEPARTMENT OF AGRICULTURE

CENTRAL EXPERIMENTAL FARM

REPORT OF THE ENTOMOLOGIST AND BOTANIST

(JAMES FLETCHER, LL.D., F.R.S.C., F.L.S.)

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REPORT

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1904.

OTTAWA, December 1, 1904.

DR. WILLIAM SAUNDERS,
Director of Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to hand you herewith a report of some of the most important subjects which have been brought officially under my notice during the past season.

The development of the Division of Entomology and Botany in the various directions has been pushed forward as evenly as possible, with an effort not to allow any work once undertaken to fall behind by giving undue attention to other branches.

Collections.—During the past year, as previously, the collections of insects and plants have been very much increased. Large additions have been made from material collected in the field, as well as also through the kindness of correspondents who have applied to the Division for help in their studies of insects and plants. The great attention which has lately been directed to Nature Study in schools has brought the officers into close contact with many teachers and students in the public schools of the country. There are few things more marked, in matters connected with the development of the country, than the keen interest which is being shown by all classes of society in those investigations which in a general way may be grouped under the head of natural history, and with which the work of the Division of Entomology and Botany is intimately associated. This includes not only a study of insects of all kinds, and plants, wild and cultivated, but also allied researches in forestry, the reclamation of land from the encroachments of the sea or of drifting sand, and also to a certain measure investigations into the habits of birds and animals with which farmers come into contact in their every-day life. This new movement in the schools of the country is giving to the growing boys and girls, who in a few years will be the citizens of Canada, an elementary knowledge of many of the common things which surround them every day of their lives, and which for this very reason are of importance to them. A practical knowledge of animals, plants and natural phenomena cannot but be of enormous assistance to the farmers of the country, whose every occupation is connected in some way with nature. The Nature Study movement is going steadily forward, and it has been a great pleasure to the officers of the Division to be in a position to encourage and help those who have taken it up so earnestly in all the provinces of the Dominion. Our collections here have been of much use in this work, and many visitors have availed themselves of the opportunity of consulting the cabinets.

Insects.—As in previous years, much time has been given to the rearing of insects, eggs or larvæ of many of which have been received by mail from all quarters or collected in the field. An exact knowledge of the preparatory stages of insects, the number of broods, and the time at which they develop, is of the greatest value when devising remedies for injurious species. Careful notes are taken of every species studied, and year by year the collections are enriched by the addition of specimens reared from the egg and prepared for the cabinets, showing all stages of growth, as well as the work of the various species. At the same time, records are kept for reference or for future use in the reports when sufficient data have accumulated or when occasion demands it.

Plants.—Extensive additions have been made to the herbarium, either from specimens sent in by correspondents for naming or as donations; and in many instances fine specimens of rare plants have been acquired by growing the plant from the seed and securing samples at different stages of development. During the year the herbarium has been gone over, and many imperfect specimens have been replaced by better ones, or additions have been made by increasing the series of various species by representatives from other localities.

The collection of weed seeds has been largely increased, and it is now a rare thing for a seed to be submitted by seedsmen or purchasers of seeds, or even to be sent in by students, which cannot be recognized. The institution of the Seed Division, under the Commissioner of Agriculture and Dairying, has had a most marked effect upon the quality of all kinds of seed now offered by seedsmen, and it may be justly said that at the present time, if purchasers will pay a reasonable price, they can easily obtain in Canada all crop seeds of the highest quality, both as to vitality and as to freedom from the seeds of other plants.

Fodder Plants.—The Experimental Grass Plots during the past season have been very attractive to visitors. The season at Ottawa was extremely favourable for the development of all fodder plants, and consequently very complete collections of all the leading hay and fodder plants were made for exhibition at the various fall fairs and other exhibitions where the government has assisted by sending exhibits. A large collection has also been made for the museum at the Central Experimental Farm.

Reclaiming Sand Hills.—A visit was paid to the large tract of shifting sand near Lachute, Que., locally known as the Argenteuil Sand Hill. This is estimated as now covering nearly one thousand acres, stretching along the Ottawa River in an elongated patch about four miles long by half a mile to one mile in width, for the most part entirely destitute of vegetation, but bearing in places clumps of spruce trees, birches, maples, tamaracks and willows. As is usually the case on such areas, the surface is very dry; but a few inches below this there is an abundance of moisture available for the support of any plants which can be protected against the drifting sand. At the request of Mr. Thomas Christie, M.P., I called upon the various farmers living around this sand hill and examined the work they had been doing in their efforts to control the sand. I found, without exception, that every one of them had taken a keen interest in fighting against the common enemy, and much good work had been done in the way of holding back the drift by planting trees and other vegetation. Since 1898 the attention of the Division has been directed to this tract of land, and a few hundreds of plants of the Beach Grass, and also of Norway and White Spruce trees, have been sent to different farmers to be planted on the sand as an experiment; but no extensive work has been carried on by the department. I was much pleased to see the success which had attended the efforts to grow trees on this apparently barren sand hill. The kinds of trees which were noticed growing wild in the scattered clumps which here and there appear, were White Pine, Tamarack, Canada Balsam, White Spruce, White Cedar, Balm of Gilead, Aspen Poplar and White Birch; and round the edges all the ordinary forest trees of the region are represented. In low spots two or three kinds of willows and the Gray Alder flourish. Of shrubs which attracted attention by their vigour and

the extent to which they had spread out in every direction, special mention may be made of the following kinds which doubtless can be made use of in prosecuting this work. The Willow-leaved Meadowsweet (*Spiræa salicifolia,* L.).—This free-growing bush, which not only produces large numbers of running roots or stolons, but also ripens much seed, was found to be covering many acres and spreading rapidly over some low spots in the central portion of the sand hill. This is a native shrub, common in all swamps and low lands. The Red Raspberry (*Rubus strigosus,* Mx.).—A form of this common shrub was seen covering a large area on the farm of Mr. Thomas McGregor, who has encouraged its growth, as well as some other native plants which occur with it. The common Blackberry (*Rubus villosus,* Ait.).—Even more luxuriant than the Red Raspberry was the Common High Blackberry, which rooted freely through the sand and threw up many stems. Both of these berry-bearing plants produce heavy crops of excellent fruit, and it seems as though they might prove a valuable resource to farmers, while at the same time performing the important office of providing a barrier against the encroachments of the sand or as a temporary shelter, while more valuable trees are being grown. Roses.—At various places old and vigorous clumps of Sweetbrier, which were evidently many years old, were seen, as well as of the little old-fashioned semi-double Cinnamon Rose. The Smooth Meadow Rose (*Rosa blanda,* Ait.) was found in spots, covering several yards in diameter and showing an unexpected power to grow up and keep its head above the drifting sand. Shrubs which also showed great vigour and which occurred in many parts of the sand hill, where evidently they had sprung up spontaneously, were the Red Osier Dogwood (*Cornus stolonifera,* Mx.) and the Beaked Hazel (*Corylus rostrata,* Ait.). Of the wild herbaceous perennials growing naturally on the sand, and the growth of which had to some extent been encouraged, the most noticeable were the Common Milkweed (*Asclepias cornuti,* Decne.), the Canada Thistle (*Cnicus arvensis,* Scop.), and Couch or Quack grass (*Agropyrum repens,* L.). There were also seen in some places a few plants of the Strawy Sedge (*Carex straminea,* Schk.), the Ox-eye Daisy and the Dandelion.

The trees which have been experimented with to the largest extent by farmers living in the locality are the White Pine, Canada Balsam Fir, the Norway Spruce, the White Spruce and the Tamarack or American Larch. Of these, the last-named has made the most rapid growth, but seems to require more protection than the sturdy spruces. The Balsam Fir has succeeded as well as the spruces, but is a less valuable tree. The Norway Spruce has been planted only to a small extent, a few hundred trees having been sent from this department three years ago. These were planted carefully, and doubtless will succeed; but it is too early as yet to compare them for this purpose with the White Spruce, which is the favourite conifer and is transplanted from the woods in the neighbourhood. The greatest satisfaction is expressed by all of the way in which willows have succeeded. The kind used for the most part is the large European Tree-Willow (*Salix alba,* L.) known mostly in this country under the name of French Willow. Large numbers of these trees have been started from cuttings and have in a single year made a remarkable growth, even from small cuttings put in with little labour in a furrow made by a plough. Such plantations were seen on the farms of Mr. John Doig and Mr. Walter Smith. On the edge of one of Mr. Doig's plantations the sand had been drifted away by the wind so as to expose the roots of one of his trees. These, by actual measurement, extended for forty feet from the central point, showing the great value of the willow as a sand binder, both from its rapid growth and from its great root production. An observation of much interest, as showing the power of the Canada Balsam to resist destruction by sand, was that this tree, when covered up to a certain extent with sand, threw out large numbers of roots from the branches which were partially submerged. (See Plate II., fig. 10.) Many samples of such branches were found upon trees which had their roots and trunks covered up with from six to ten feet of sand. Experiments with Beach Grass and the Sea Lyme Grass have been very satisfactory, particularly where the former has been planted on

exposed banks. In low, undisturbed spots the Sea Lyme Grass has succeeded rather better than the Beach Grass. Tufts of both of these grasses were found in some places to have extended four feet in each direction by the end of the second year, and on Mr. Walter Smith's land one clump was found which had a thick growth four feet across in the centre, with five smaller shoots round it and 18 shoots just showing through the sand, which will produce tufts of leaves next spring at a radius of twelve feet from the centre.

It is hoped next year to encourage this work by sending a large consignment of Beach Grass and several thousand cuttings of those willows and poplars which have shown the greatest vigour at Ottawa and at our western experimental farms. The enthusiasm and interest shown in this subject by the farmers themselves, every one of whom has already gone to much trouble and expense, is most encouraging. I can see no reason why in a few years this large tract of sand may not be brought under control.

Meetings.—Meetings of farmers, dairymen, fruit growers, &c., have been attended whenever other official duties would allow of my absence from Ottawa.

December 28, 1903: St. Louis, Mo.—Annual meetings of the Society for the Promotion of Agricultural Science, of the Association of Economic Entomologists and of the American Association for the Advancement of Science.

January 29, 1904 : Cowansville, Que.—Convention of District of Bedford Dairymen's Association.

February 12 : Ormstown, Que.—Huntingdon Dairymen's Association.

April 18 : Perth, Ont—Horticultural Society and address to school children of the Public Schools in the town hall.

May 5 : St. Catharines, Ont.—Meeting of fruit growers to discuss the San Jose Scale remedies.

May 6 : Toronto.—Normal School : Address on Nature Study.—Toronto Branch of the Entomological Society of Ontario and Toronto Horticultural Society—joint meeting : Address on 'The Opening of Spring and Spring Work.'

June 14 : Amherst, N.S. ; and June 18 : Halifax, N.S.—Meetings of Maritime Stock Breeders' Association and Nova Scotia Farmers' Association.

June 21 to 24 : St. John, N.B. ; June 16 : Kentville, N.S.—Address before King's County Board of Trade on 'Orchard Insects.'

June 27 and 28 : Gagetown, N.B.—Address before Farmers' and Dairymen's Association on 'Farm Insects,' and attending spraying demonstration in orchard.

July 11 to August 11.—In Manitoba and the North-west Territories, holding weed meetings for the North-west government.

September 5 : Brome, Que.—Attending the Brome County Fair and judging horticultural exhibits.

September 9 to 17 : Halifax, N.S.—Attending the Nova Scotia Provincial Exhibition in company with the Dominion Live Stock Commissioner. Meeting farmers and fruit growers in the Farmers' Pavilion and delivering addresses on Noxious Weeds and Injurious Insects.

September 19 to 23: St. John, N.B.—Attending Canada's International Exhibition and judging the natural history exhibits sent in by the school children of the province. This competition is worthy of special mention on account of the excellence and number of collections sent in. No less than 83 separate collections, aggregating nearly three thousand specimens, were on exhibition and formed a most attractive exhibit. For the most part, the specimens were well preserved, neatly mounted and labelled. The identifications in most of the collections were also as accurate as could be expected under the circumstances. On the whole, I believe that this competition was the most extensive and best managed of any similar effort which has ever taken place in Canada. The example of the Exhibition Association may well be followed by other similar institutions.

September 24 to 30: Charlottetown, P.E.I.—Provincial Exhibition. Attending meetings and giving addresses in the Farmers' Pavilion upon Weeds, Hay and Pasture Grasses and Injurious Insects.

October 19: Lachute, Que.—Visiting the Argenteuil Sand Hill and discussing with farmers means of controlling the drifting sand.

October 21: Whitby, Ont.—Visiting the Model Fair Grounds with the Live Stock Commissioner and examining the illustration plots of various crops; and also the fodder crops grown in the district.

October 26 and 27: London, Ont.—Annual meeting of the Entomological Society of Ontario: 'Injurious Insects of the Year,' 'Entomological Record for 1904.'

November 15: Toronto, Ont.—Provincial Fruit, Flower and Honey Show: Address on 'The Value of Bees to the Fruit-grower.'

In addition to the above, Mr. Arthur Gibson attended the County of Carleton Annual Exhibition at Richmond, Ont., and judged the natural history exhibits made by the teachers and school children of the county. These exhibits were on the whole very satisfactory, and showed good careful work on the part of the teachers.

Mr. Gibson also attended the annual meeting of the Entomological Society of Ontario at London, and took an active and acceptable part in the proceedings, reading two papers: 'Further Notes on Basswood or Linden Insects,' and 'The Columbine Borer (*Papaipema purpurifascia*, G. & R.).

Acknowledgments.—I have again gratefully to acknowledge many favours from specialists who have assisted me with identifications of many specimens of insects received for the collections during the past year. My thanks are specially due to Dr. L. O. Howard, Chief of the Bureau of Entomology at Washington, and members of his staff, particularly Dr. H. G. Dyar, Dr. W. H. Ashmead, Messrs. Schwarz, Coquillett and Busck; also to Prof. J. B. Smith, of New Jersey; Mr. W. D. Kearfott, of Montclair, N.J.; Prof. J. S. Hine, of Columbus, Ohio, and Rev. G. W. Taylor, Wellington, B.C.

Valuable additions to the collections of insects have been made by the following:

Mr. F. H. Wolley-Dod, Millarville, Alta.—A collection of named noctuidæ from Alberta.

Mr. T. N. Willing, Regina, N.W.T.—Many specimens of insects of all orders from the North-west Territories.

Mr. Norman Criddle, Aweme, Man.—Many rare moths and other insects from Manitoba.

Mr. W. Metcalfe, Ottawa.—A large collection of minute diptera and other insects beautifully pinned, mounted and labelled.

Mr. A. W. Hanham, Victoria, B.C.—A large collection of pinned hymenoptera, diptera and hemiptera taken in Manitoba and British Columbia.

Mr. E. F. Heath, Cartwright, Man.—A collection of Manitoban moths in papers.

Mr. C. H. Young, Ottawa.—Specimens of rare moths taken at Ottawa.

Mr. E. P. Venables, Vernon, B.C.—A collection of named *Bombi* taken at Vernon, B.C.

Correspondence.—The correspondence of this Division has been sufficient during the past year to take up every minute of the time of the officers which could be spared from time necessary for investigation. Many thousands of specimens of insects and plants have been received from students for naming. This requires much time, but is of great value in the work of the Division in bringing the officers into contact with students all over the country and in learning of the occurrence of many insects and plants, which otherwise would not come to their notice. From December 1, 1903, until November 30, 1904, the number of letters, exclusive of circulars, registered in the Division as received on official business was 3,231, and the number despatched was 2,909.

I have the honour to be, Sir,

Your obedient servant,

JAMES FLETCHER,

Entomologist and Botanist.

DIVISION OF ENTOMOLOGY.

CEREALS.

The season of 1904 in all parts of the Dominion has been remarkably irregular and uncertain. Extensive areas have suffered from drought, while in other places there has been trouble from too much rain at certain periods; crops, accordingly, have been very irregular. Through the greater part of the Maritime Provinces and in the eastern part of the province of Quebec, a prolonged drought during the months of June, July and August reduced enormously all hay and grain crops. In the western portion of the province of Quebec and in eastern Ontario, weather conditions were very favourable and excellent crops of grain and hay were secured. In western Ontario, on the other hand, and in the whole of the province of British Columbia, hot dry weather prevailed and somewhat reduced crops of all kinds. The Ontario November crop report describes the wheat crop as below the average and rather light in weight; barley as one of the most successful crops of the year; oats a splendid crop, yield and quality most gratifying. Throughout the Dominion, however, the season on the whole has been cool and backward. In the North-west Territories and Manitoba the growing season began late; but with improved summer conditions and no killing frosts until rather later than usual, a large crop was reaped. The quality was not quite as high as was at one time hoped for, owing to rain at harvest time and slight frosts in some localities, and also to a certain amount of injury by rust. Rust is almost unknown in the West as a serious enemy of cereal crops; but during the past season a more severe epidemic of this destructive parasite made itself manifest towards the end of August, than has ever previously been recorded. Mr. J. R. C. Honeyman, the Deputy Commissioner of Agriculture for the North-west Territories, although stating that the presence of rust last summer was a factor to be considered, claims that practically it did not affect the crops in the Territories to any appreciable degree. Writing on November 16, he says: 'There is a large amount of very good grain in the country, and prices are satisfactory. However, a comparatively small proportion of the crop has been marketed, owing to the continued fine weather, which enables farmers even at the date of writing to continue their fall ploughing.'

Mr. J. R. Anderson, Deputy Minister of Agriculture for British Columbia, writes: 'The abnormally dry season which extended through the whole of the province, had the effect of reducing considerably the production of all crops in those parts where irrigation is not practised, because it is unnecessary. Spring wheat was generally a failure where it is grown for milling purposes. Fall wheat was better, but on the whole, milling wheat was short. Nevertheless, some fine samples were produced. Kansas Red from Spallumcheen weighed 69½ lbs. per bushel, with a fine, hard, plump grain. Oats and other small grains were good where the seed was got in early, and on irrigated land. In dry regions these crops were indifferent.'

In Northern Alberta the summer was fine and dry, and grain crops were better than they had been for two or three years, except in some instances where poor seed oats had been sown. No mention was made of rust. In Manitoba, however, the injury by the Black Stem Rust caused great anxiety to farmers. Some crops were actually cut green or before they were ripe to save further damage. The districts most affected were between Brandon and Winnipeg and in the south and west of the province. Loss from this cause was not confined to the West. Reports from Ontario and Quebec mention rust on wheat, oats and barley, and a consequent shrinkage in those

crops. An undetermined injury referred to as 'Dead Heads' by settlers also occurred rather widely in Manitoba just before wheat harvest. Unfortunately, no cause for this injury which involved patches of from two to fifteen feet in diameter, could be discovered by my correspondents, who made investigations in accordance with suggestions sent to them. Neither fungus nor insect enemy could be discovered. Mr. Geo. H. Greig, Secretary of Live Stock Associations of Manitoba, wrote that the injury ceased about August 20, and that in speaking with the farmers in the district where this occurred, the opinion seemed to prevail that new land was worse affected than old, and he estimated the loss in the fields which showed most of the injury at about 5 per cent.

Among insects which have attracted attention by their numbers on cereal crops during the season of 1904, mention may be made of the following:—

WIREWORMS.—Wireworms in grain fields were complained of in New Brunswick, near St. John, on Prince Edward Island, at Kensington, and at Qu'Appelle in the North-west Territories. These troublesome larvæ, for which up to the present time no satisfactory remedy has been discovered, did much harm by eating into the young sprouting grains of wheat. It was noticed by Mr. William Henley, of Qu'Appelle, that oats sown on the same land where wheat was being destroyed, were not injured by the wireworms. The destruction of the wheat, however, was considerable. He writes under date June 20:—'Wireworms are destroying our wheat crop in the Wascana District (T. 13, R. 15, W. of II., 30 miles south of Qu'Appelle). This is heavy hummocky land full of humus. I broke a hundred acres last summer, disked it in the fall and harrowed it before and after seeding this spring. I shall not get over half a crop from it. I am breaking another hundred acres this summer, and should like to avoid this trouble next season, if possible. Would more cultivation in the spring have any effect on this insect, or would you recommend putting on extra seed? I don't think this worm does much harm after the wheat has germinated. We had two weeks of cold weather this spring after seeding, and the seed did not start to grow for some time. This was when the wireworms did most harm.'

A remedy which has given a measure of satisfaction to those who have tried it, is to plough the land twice in autumn—once in August, when the wireworms (the larvæ of several species of Click Beetles) change to the pupal condition, in which they are soft and easily injured, and then again in October or later, when the perfect beetles have formed but are still too soft and delicate to stand the cold of autumn and winter if their pupal cell is broken. This late ploughing also exposes them to many enemies. In the North-west, as Mr. Henley has pointed out, it is very rarely possible to plough land as late as October. The present open season, nearly up to the end of November, gives farmers a good opportunity to try this remedy. It has been noticed that oats are not so much attacked as wheat; and barley and rye are even less so, therefore, when land is found to be badly infested with wireworms, it will be advisable to sow other crops than wheat.

CUTWORMS IN GRAIN.—In the middle of July the 'Nor'-West Farmer' referred to the Division several complaints of injury to wheat crops by cutworms (Plate I, fig. 1), and specimens were received from Manitonas, Man. These proved to be the Red-backed Cutworm *(Paragrotis ochrogaster,* Gn.), which is a very general feeder, but, as a rule, restricts itself in a large measure to the weeds growing in grain crops, instead of attacking the grain. Occasionally, however, as in the oat crops of Manitoba in 1901, widespread injury was done by this cutworm; and, in 1900, as well as in 1901, several undoubted instances were reported of its attacking wheat. This bad habit, however, must be considered exceptional; and it is particularly to low vegetables and root crops that the Red-backed Cutworm does harm. The Glassy Cutworm (*Hadena devastatrix,* Brace), a greenish white caterpillar with a red head, which works beneath the ground, damaged wheat fields seriously in the neighbourhood of Virden, Man.

In grain fields it is difficult, as a rule, to apply remedies for cutworms; but, as many of the different kinds assume a marching habit as they clear away the food be-

fore them, it is frequently possible to prevent damage to a large extent by applying poisoned bait in advance of their line of march. The poisoned bran remedy, which gives such remarkably good results against all surface feeding cutworms, is probably the best form of bait. This can be scattered lightly through the grain near the spots where the caterpillars are numerous, and the small particles of bran will be found by the cutworms, which eat this material with avidity. For the Glassy Cutworm, which feeds almost entirely underground, this remedy would be of little avail, and the best means of combating this insect is to keep the land to be used for small grain crops the following year as free as possible from long grass and weeds in the autumn before. Prairie or sod land which is to be broken for seeding the next year should be fed off as late as possible or mowed before breaking. In this way the female moths will not be attracted to the tall vegetation on such land when laying their eggs.

GRASSHOPPERS.—I visited the districts in Central Manitoba lying between Treesbank and Douglas in the middle of July, and saw no traces of injury by locusts. Mr. N. Criddle, of Aweme, writes under date of November 1: 'As was anticipated, locusts did not hatch out in sufficient numbers to cause any loss to farmers in this district. A few reports of their being unduly numerous were heard in the spring from places south-east of here; but, as far as I can learn, very little, if any, damage was done. The gradual disappearance of these troublesome pests seems to have been brought about chiefly by the multiplication of their well known parasites, mention of which was made in my last year's report.'

The kinds of grasshoppers which have been devastating the crops in Central Manitoba for the last four years are the Rocky Mountain Locust (*Melanoplus spretus*, Uhler), the Lesser Migratory Locust (*M. atlanis*, Riley), and Packard's Locust (*M. packardii*, Scud.). The two parasites referred to by Mr. Criddle are two blister beetles *Epicauta sericans*, Lec., and *Epicauta pennsylvanica*, DeG., as well as two or three kinds of *Tachina* flies.

In some of the dry regions of British Columbia another species of locust, *Camnula pellucida*, Scud., appeared in a few places, and did a good deal of harm on the ranges. Mr. George Packham, of the Plateau ranch, Okanagan Mission, writes on June 25: 'Grasshoppers are coming out in thousands again this year. Last year they destroyed most of the crops and damaged the young orchards considerably. Is there nothing that can be done to check them? Is there not a fungous disease that the Australian government supplies to settlers? If so, could not our government supply it to us at cost price? It is important that we get it immediately, or we shall lose acres of vegetables and thousands of young trees.' In view of the great success which had been obtained by Mr. Criddle in controlling vast hordes of grasshoppers in Manitoba in a practical way with the Criddle mixture, I recommended Mr. Packham to try that mixture in the Okanagan country. It has been noticed that the Pellucid Locust, which was the species there prevalent, has the habit of occurring in dense swarms in rather restricted localities, and therefore gives a good opportunity for the application of poison.

The Criddle mixture, for convenience, is made in quantities of half a barrel at a time. It consists of fresh horse droppings 100 parts, Paris green 1 part (=1 pound), and salt 2 pounds, dissolved in half a pail of water, and the whole mixed together. In this connection, Mr. Criddle says: 'We usually measure with a three-gallon patent pail, because it is more convenient to farmers than to weigh the material. Five pails we calculate approximately equal 100 parts of horse droppings, and each part equals in bulk one pound of Paris green. The great drawback in using weights is that horse droppings are not always of the same weight.'

The propagation and wholesale cultivation of the fungous disease for the destruction of grasshoppers of all kinds, which is mentioned by Mr. Packham and has been inquired about from time to time by many other correspondents, I regret to say, has not proved to be, on the whole, of much service in fighting outbreaks of injurious locusts.

For a short period, and in restricted localities, with all conditions favourable, good results have occasionally been obtained; but the difficulty of preserving the spores alive and using them when required, has been so great that all entomologists who have experimented with the fungus have, after a short time, relinquished the effort in favour of other methods not so dependent for their most effective use on climatic conditions. Hopper dozers and other mechanical contrivances have proved of much service; but the best results have followed agricultural methods of control, such as the early ploughing down of all stubble lands, in which by preference the eggs are laid, before the young emerge in spring or have grown to such a size as to be able to save themselves by hopping or flying, so as to avoid being ploughed down and buried.

The HESSIAN FLY *(Cecidomyia destructor,* Say.).—Injury by this destructive enemy of the wheat crop has been slight this year. Most reports merely refer to its absence. Last year specimens were found as far west as Indian Head, N.W.T. In Manitoba it has done less harm by far than in 1903. Mr. Norman Criddle, who has been on the lookout for it, says: 'The only report of this insect comes from Mr. Cooper, of Treesbank, who states that quite a number of puparia were to be found on his stubble fields this autumn and that he estimated the damage on his farm at about half a bushel to the acre. Elsewhere in the province, it is just possible that this insect may have escaped notice on account of the damage done by rust. There was no appearance of Hessian Fly here at Aweme.'

Prof. F. M. Webster, who is making a special study of wheat insects in the United States, writes at the end of this season: 'I found Hessian Fly in large quantities in North Dakota, quite as bad as in many places further south. You will be interested in hearing that from a lot of stubble collected west of Fargo, I have not reared a single adult this autumn; but from stubble collected at Lincoln, Nebraska, we get plenty of adults, showing that there must be a dropping out of the fall brood somewhere between these two localities.'

This observation confirms the opinion that there is only one brood of the Hessian Fly each year in our western wheat fields. This is an important fact, as indicating a proper remedy, and shows the value of cutting wheat high and then burning over the stubble before the time when the flies emerge in spring. In the Ontario November Crop Returns we find: 'The crop suffered much less than in recent years from Hessian Fly and other insects;' and 'in the new fall wheat little injury was complained of, compared with the ravages of this pest during the past three or four years.' In Prince Edward Island, where the Hessian Fly is always present to some extent, little harm was done, but specimens of infested straws were received from Mr. A. M. McMillan, of Eldon, P.E.I.

WHEAT-STEM SAWFLY [*Cephus pygmæus,* L. (?)].—The intermittent manner in which this insect attacks wheat in the North-west was again demonstrated this year. It was not reported from any of the localities where it did harm during the past two years. The only place where a crop was injured conspicuously was at North Portal, Assa. Mr. George Harris writes under date August 24: 'I send samples of wheat injured by a small white worm. The attack is worst on the edges of fields, but is present all through the grain. Where the plants stand thick, you can cut with a binder; but where thin, the wheat falls down and there are patches three and four feet square, which are quite flat.'

The worm which causes this breaking of the straw is the larva of a slender black four-winged sawfly, about one-third of an inch in length, banded and spotted with yellow. The eggs are inserted into the straw by the females near the top of the stem; and the grub on hatching eats its way down to the root, near which it passes the winter in a cocoon spun inside the stem, but above which it has first gnawed almost through the walls of the straw, so that about harvest time injured stems fall over easily and break off, leaving the grub inside the stubble, where it remains, and about June of the following year turns first to a pupa and then to the perfect fly. Burning over

stubble fields and ploughing down all land left for summer-fallow early, so that the cocoons may be destroyed by the burning or buried so deeply that the flies cannot emerge, are the remedies recommended.

The GRAIN APHIS *(Nectarophora granaria,* Kirby).—It is probable that two or three species of plant-lice have been spoken of collectively by correspondents under the name of the Grain Aphis, as there is a remarkable difference in the appearance and colour of many of the plant-lice described in their letters, and very few send in specimens of what they consider a so well known insect. The grain plant-lice were more complained of this year in the West than any other enemies of cereal crops. They were exceedingly abundant in many places, and did some harm by sapping the stem and grain and causing shrunken wheat. Specimens were sent from New Brunswick by Mr. W. H. Moore, of Scotch Lake, and reports of unusual abundance were received from several places in Ontario. Nevertheless, there was little appreciable injury to grain crops in the East. In Manitoba and the North-west grain plant-lice were in places so abundant as to cause a good deal of anxiety. Mr. T. N. Willing, the Chief Territorial Weed Inspector, of Regina, reports that the Grain Aphis was very plentiful at some points, particularly north of Wapella, N.W.T. 'They were so abundant on Mr. F. Carr Dufton's farm, Wapella, and that of Mr. W. M. Gordon, Hazelcliffe, that the binder was actually stopped by reason of the canvas slipping on the rollers, from the slipperiness caused by the crushed plant-lice, and these were cleared off from the platform by the shovelful.'—T. N. WILLING. '

'Pilot Mound, Man., Aug. 17.—I send wheat heads attacked by the Grain Aphis. I have a large acreage in which the grain is infested; but the only harm I can see that they do so far is to delay ripening. In walking only a short distance into the standing grain my clothing became covered with these insects.'

'Aug. 28.—The plant-lice which were so abundant when I last wrote, soon afterwards suddenly disappeared. They got wings about August 18 and flew away, I hope, never to return.'—PHIL. W. ROBINSON.

'Winnipeg, Man., Sept. 6.—We send sample of wheat received from a farmer at Wawanesa, Man. You will notice that it is affected by a small insect which is working on the head. The farmer writes : "The heads of the wheat are covered with a small insect of a green and black colour, which seems to be a bad pest. The heads of the wheat are covered with them and there must be millions in a single field. They seem to be sucking out the juice of the straw and the berry.'—W. J. BLACK, Editor *Farmers' Advocate.*

'Yorkton District, Assa. (30.25.2.W. of 2nd), Sept. 13.—There was an insect on the grain this year which, had it come sooner, would have done a great deal of damage. There are millions of them on the oats, and I understand they are on the wheat also. They cluster around the kernel.'—A. C. GIBSON.

So far, no treatment has been discovered for controlling plant-lice on grain crops; but fortunately, they very seldom affect the output to any considerable extent; for an excessive occurrence of these insects is invariably attended by a correspondingly abundant development of parasites which feed upon them.

The WHEAT MIDGE *(Diplosis tritici,* Kirby).—It is many years since any noticeable loss from the larvæ of the Wheat Midge, usually called 'The Weevil' by farmers and millers, has taken place. Fifteen years ago the injury through the country was enormous, but suddenly, about 1889, the insect practically disappeared from our wheat fields. In 1898 a rather severe outbreak—the loss amounting to about 25 per cent of the crop—appeared as suddenly in the Niagara Peninsula, particularly along the lake shore in the county of Lincoln. Nothing has been heard of the Wheat Midge since that time, there or elsewhere, until the past summer, when specimens were sent from the fertile Chilliwack district of the Fraser River valley, in British Columbia. Mr. J. R. Anderson, in his report on the crops of the year, says : 'The Wheat Midge

(Diplosis tritici, Kirby) made its appearance at Chilliwack, but does not seem to have shown itself elsewhere. Where noticed, the infested wheat was destroyed by fire.'

Specimens of wheat heads more heavily infested than any I have ever seen, were received from Mr. Henry Kipp, of Chilliwack.

'Chilliwack, July 27.—I enclose heads of wheat infested by a small red maggot. There were a few last year, but this year my field is ruined. Please let me know what it is, and send a remedy if there is any. I believe there are hundreds of acres more or less injured by this insect. You will be doing the farmers of this district a great favour if you publish a remedy for it so that we may be ready to protect ourselves another year.'—R. ROBERTS.

'Chilliwack, July 28.—I enclose heads of wheat infested with a little red insect, which is attacking all the wheat crops here. Is there any remedy? I suppose not, as the wheat is so far advanced and is just beginning to ripen. I hear rumours of barley being attacked. So far, oats and peas are not.. I see under the microscope this little insect resembles a minute worm. Most people, including myself, are going to cut the wheat green.'—G. MAXWELL STUART.

'Chilliwack, Nov. 24.—As far as I can hear, wheat was damaged by the Wheat Midge more or less all over the lower Fraser valley; the extent of the injury varied according to locality and to the state the wheat was in when the Midge attacked it. On the whole, the average would be, I think, less than one-third of the crop for the turn out. I heard of one farmer who only got 10 sacks of wheat off 10 acres; another got 25 bushels off five acres; he estimated the crop, before the Midge attacked it, at at least 20 bushels to the acre. On the other hand, Mr. Evans, of Sumas, had his wheat in very early; and it was not injured at all. I suppose the wheat had got too hard for the Midge; and for the same reason the fall wheat here was not hurt at all. I do not put in much wheat, my land being better suited for clover and peas; but off two acres which looked very well before the Midge came, I got only about two sacks. A good many cut their wheat for hay as soon as they knew it was attacked. Do you think this insect is likely to occur again next year? It would be a useful hint to farmers if you could include in your report a suggestion as to whether it would be wise to sow much wheat or not.'—G. MAXWELL STUART.

As to sowing spring wheat next year in the Chilliwack valley, it would certainly be wiser not to do so, but to use the land for some other crop such as oats or barley, which are not attacked by the Wheat Midge. It is, of course, possible that the Midge may not be abundant next year; but it is much more likely to be present in some numbers, which would make it unwise to grow wheat when the land can be used for so many other valuable crops.

'Chilliwack, November 28.—*Re* losses from Wheat Midge in this valley, I may say they were even more serious than I first thought. After attending a number of threshings, I am sure fully half of the wheat crop was destroyed by it; there would be found several bushels of the grub underneath the machine after it had worked one or two hours. But a few like myself cut their wheat and made hay when the insect was found to be bad; but I may say the loss was not felt as bad here as it would have been in a wheat-growing district; for the farmers here only grow wheat for feed, and only a comparatively small acreage is annually sown to wheat; so the loss, although considerable, will not be felt very much, and the chickens will have to eat something else. I notice an increase in the acreage of fall wheat sown this fall; for, strange to say, the insect does no harm to fall wheat, and a few fields of very early spring wheat escaped the Midge. I have just rubbed out a few heads of the wheat which I cut for hay, and find the grub still there, with no change, as far as I can see, since I first noticed it.'—R. ROBERTS.

All the samples of infested wheat received were remarkable for the enormous numbers of the larvæ clustered round the grains in each floret; and, although few farmers reported injury by the Midge, this was without doubt great where the insect

occurred. Immediately on receipt of the samples an article was prepared for the *Province* newspaper of Vancouver, B.C., in which the insect was described and the best steps to take were mentioned, so that as much as possible loss might be minimized in the future. The Wheat Midge possibly attacks some grasses, but has never been detected, as suggested above, on barley nor upon oats and peas.

The Wheat Midge and its attack are thus described in my report for 1888, page 49, which I reprint here, as I have nothing further to add to it in the way of useful information:—

'The Wheat Midge is more widely known in Canada under the inaccurate designation of 'Weevil,' a term which must be discouraged, because it belongs to another class of insects altogether. The weevils are hard-shelled beetles, with elongated snouts, while the Wheat Midge in its larval stage is a legless maggot, and, when in the perfect state, a delicate gnat-like creature with gauzy wings. The life history of the Wheat Midge, as at present understood, is as follows:—During the month of June, just when wheat is in blossom, tiny yellow midges with black eyes and yellow bodies may be seen flying over the fields, particularly on dull days or towards evening. Large numbers of the same midges may also be seen in houses as soon as the lamps are lighted. These are the Wheat Midge and the parents of the Red Maggot of wheat.

'The body of the female fly is prolonged into a long slender tube which can be extended or drawn in at pleasure. With this tube, which is called the ovipositor, she pushes her minute eggs down between the chaff of the green wheat ear. In about a week these eggs hatch into small transparent yellowish maggots, which at once attack the forming grain. Gnawing through the outer skin of the kernel of wheat, they extract its juices and prevent it from filling out properly. As these larvæ grow older, they gradually become darker in colour until they acquire the tint which has given them the name they are best known by in England, "the Red Maggot of the wheat." Grain injured by the Midge has a characteristic shrivelled appearance, known amongst millers as "fly struck." There are sometimes four or five maggots to each grain in an ear.* As soon as the maggots are full grown they either work their way up between the scales of chaff and fall to the ground, or remain in the ears until the crop is carried. Those which fall to the ground—and these are by far the most numerous—penetrate about an inch beneath the surface, where they spin a small cocoon of exceeding thinness, which fits so closely to their bodies that it is sometimes thought to be only the skin hardened, in the same manner as takes place in the case of many other flies when they pass through their pupal or quiet state. It was generally supposed that the perfect flies from these pupæ did not appear until June in the following year. This, however, is not always the case, for, on a warm, damp evening in August, and again in the beginning of September, 1888, large numbers flew into my study and were killed at the lamp. Prof. F. M. Webster, a special agent of the United States Department of Agriculture, on one occasion bred considerable numbers of perfect Midges in the month of July, from heads of wheat which had been badly attacked by the red maggots during the previous month; and, off and on, during the rest of the summer until November, he caught the perfect insects at large. In the report of the United States Entomologist for 1884 the same observer records as follows:—"From September 4 to 15, I not only found larvæ in considerable abundance under the sheaths of volunteer wheat, but adults too in the same situation, and also on the outside of the plant or hovering above the upper leaves. From a quantity of this wheat placed in a breeding cage, on September 7, appeared three or four adults." Not only, then, did these maggots of June produce perfect flies that same summer, but there was a second brood which had time to lay eggs in the young fall wheat. That this insect has a double life history, living both in the ears and later in the season in the shoots of young

*There were from 10 to 15 in almost every instance with each grain in the heads sent from British Columbia this year.

wheat plants, is an important discovery made by Prof. Webster, and suggests another means of checking its ravages.'

Remedies.—The remedies for the Wheat Midge, as for all other insects which attack crops, depend largely upon its habits and the way in which it passes the winter. Those methods which have given the best results are as follows :—

1. Deep ploughing directly the crop is carried, so as to bury the larvæ so deep that the flies cannot work their way out through the soil.

2. The burning of all chaff, dust and rubbish known as 'screenings' or 'tailings' from beneath the threshing machines, as these contain many of the larvæ which are carried with the crop. If fed to chickens or domestic animals, this should be done in a place where none of the puparia can escape destruction.

3. Clean farming, including the cutting of all grasses along the edges of fields and the ploughing down of all volunteer crops found in wheat fields before winter sets in, so as to destroy an autumn brood where one exists.

4. The cultivation of such varieties of wheat as experience has shown are least affected by this insect. There is a great difference in kinds of wheat in this respect, and from time to time so-called 'midge-proof' varieties have been introduced, but it is probable that there is no truly midge-proof variety of wheat as yet known.

The PEA WEEVIL *(Bruchus pisorum,* Linn.).—The satisfactory state of affairs referred to in my last year's report as to the sudden and remarkable decrease in the numbers of this pest has continued, and, even to a greater degree, during the summer of 1904. This sudden cessation of activity on the part of such a persistent enemy cannot be accounted for by any one cause; but it must be claimed to be due, to some extent at any rate, to the persistent work which has been done by entomologists in stirring up farmers to greater care in treating their seed pease before sowing them, and in harvesting and treating the crop as soon as possible after it is ripe. Many farmers, for fear of loss from the depredations of the Pea Weevil, gave up growing peas altogether during the last two seasons. In 1903 the numbers of the Pea Weevil were perceptibly reduced, but no natural parasites such as frequently bring down the numbers of other insects when they increase unduly, could be detected to account for this. The winter of 1903-4 was more severe, both from its duration and the intensity of the cold than has been experienced for many years. There is no doubt that the cold weather destroyed many of the weevils which had emerged in the autumn and were hibernating around barns and buildings. It is probable, too, that many of those still remaining in the seeds through the winter were also killed by the cold. In some rather extensive experiments carried on during two or three years to decide whether there was any exact limit to the low temperature which could be borne with impunity by the Pea Weevil, I found that beetles exposed inside the pease, both with the skin of the pea intact or with the cell cap pushed off, were killed at between 18 to 20 degrees below zero, Fahr. On several occasions during last winter the thermometer dropped lower than 20 degrees below zero, Fahr., in those districts of Ontario where the best seed pease are grown. Mr. Geo. E. Fisher, a practical farmer and careful observer of insect life, writing from Burlington, Ont., on September 29, says : 'The pea crop here is now being threshed. It is a good crop and characterized by the entire absence of bugs. This substantiates my contention that cold weather settles the Pea Bug. I believe there will be a large acreage put in to peas next year.'

Prof. C. C. James, in his November crop report for Ontario, says : 'The round or common field-pea has not been widely sown during the past three or four years owing to the weevil or "bug." The yield and general quality of pease this season, however, will do much to restore confidence in the growing of this crop. The injury from weevil was comparatively slight, and a larger area of peas may be looked for next year.'

Mr. J. D. Evans, President of the Entomological Society of Ontario, who has made inquiries for me in Prince Edward county, one of the most important districts in Canada for the production of first-class seed and pease, writes on November 11: 'The Pea Weevil was not destructive at all this year; in fact, it seems to have entirely disappeared. There were none found at Picton, Bloomfield, Wellington, Trenton or Frankford. Mr. Cooper, of Bloomfield, and Mr. W. P. Niles, of Wellington, both well known to you as first-class men, report its apparent disappearance in the above-mentioned localities.'

I draw special attention to the great diminution in the numbers of the Pea Weevil at the present time, in the hope of inducing growers to avail themselves of this exceptional opportunity of pressing home their advantage now when the infestation is so slight, and when, therefore, every insect killed is of much greater importance in the conflict than when Pea Weevils are occurring in the incredible numbers in which they existed in Canada only three years ago. I again repeat that I can see no reason why the Pea Weevil should not be entirely wiped out in Ontario.

There are special features about the attack of this insect which render its control a simpler matter than is usually the case with injuries of an equal magnitude. The Pea Weevil is not a native of North America, and has no other known food plant than the cultivated pea, which, being an exotic plant, will not live over the winter in our climate if seed is left in the open field; consequently, every seed sown for the pea crop of the year must, before it is sown, have been under the control of some one by whom it could have been treated before sowing to destroy the contained weevil if it had one. Fumigation with bisulphide of carbon is a certain, effective, easy and cheap remedy, which is well known and can be applied by any one. If all growers of pease, will combine to do this this year, when on account of the cool season of 1904, it is not likely that many of the weevils have left the seed, by far the greater number of the Pea Weevils now remaining in the country can be destroyed before another season opens. This, however, alone will not be sufficient. The knowledge of the life history of the insect must be made much more widely known to farmers than is the case; for, notwithstanding all that has been written on the subject and the attention which has been given to it at farmers' institute meetings, I have received during the past season a great many inquiries as to the best means of treating pease before sowing; and further steps must be taken at the proper time of the year to spread more widely a general knowledge of the subject, so that those growing seed and sowing pease, may understand the reason why certain steps are advised. My recommendations are :

1. That all pease for seed should be treated before they are sown, whether the weevil is thought to be present or not, and that seeding should be as early as can be, so as to get the crop ripe and ready for treatment at the earliest possible season.

2. That pea-growers should harvest their pease as much on the green side as is safe, rather than, as is usually done, waiting until they are dead ripe. This has many advantages; not only is the straw of much higher quality for feed, but the seed is heavier and better for every purpose. The pease should be threshed as soon as dry enough, and then fumigated at once. The weevils will not have completed their growth and will have destroyed a smaller proportion of the bulk of the seeds than if they were left until later in the winter. It is certain that weevils in all stages of growth may be killed inside the pease by fumigating with bisulphide of carbon. Consequently, if growers will sow early and harvest and thresh a little earlier than usual, and either themselves treat their seed immediately or sell to the grain buyers, who for their own sakes will do this, much good must surely result. When for any reason pease cannot be treated at once or disposed of, they should be bagged up and the sacks tied up immediately so as to prevent the escape of any weevils which might emerge in the autumn. When the grain is required for feeding, and therefore it is thought not necessary to fumigate, pease should be ground as soon as they are dry enough; and, for the convenience of grinding and to prevent the meal from becoming musty, some old pease should be mixed with the new before passing them through the grain grinder.

3. That everybody who understands the gravity of this question should use every endeavour to persuade all growers of pease to abstain from sowing any pease which contain living weevils, and, when purchasing seed, to refuse determinedly to buy any without an assurance from the seed merchant that they have been treated, and, even with this assurance, to examine for themselves to see that any contained weevils are really dead. There are two points which should always be remembered by those who purchase pease for sowing. Seeds which have been injured by weevil are so much reduced in vitality and producing power that they are only worth about one-quarter as much as sound seed, and also, that treatment with bisulphide of carbon in no way injures the pease, whether they are to be used for seed or to be fed to stock.

FIELD CROPS.

The irregular nature of the weather during the summer months of 1904, which has already been referred to under cereal crops, was manifested even more plainly by its effects upon fodder crops. Good hay crops were the exception, perhaps the best being secured in western Quebec and central and northern Ontario. Corn was nowhere heavy nor well developed. Complaints of poor seed were frequent; but it is possible that some of the disappointment was due rather to weather conditions than to lack of quality in the seed. Late spring frosts did some injury, and early frosts in autumn reduced very much the weight of ensilage corn per acre. The Ontario returns sum up the crop as follows :—'Corn for the silo is described by some as being of inferior quality, while many others claim that it will be good or of fair quality. Taken altogether, however, it has been a decidedly poor year for corn.' In the Maritime Provinces and Quebec some injury was done by cutworms, necessitating replanting and a consequent retarding of the crop, so that it was caught by frost in the autumn. The drought which prevailed from the Temiscouata district in Quebec to the sea coast reduced enormously hay crops, which up till the first of June were apparently in a flourishing condition. Writing of the climatic conditions in Prince Edward Island, the Rev. Father Burke says :—'The season opened with much promise, and there was more soil moisture than we have had for several years. The weather was warm and genial, and the opportunity for getting the crop in was unexcelled. Towards the end of June, however, the complete absence of rain began to be felt, and, as almost every day we had high winds from the south-west, growing crops became a greater concern to farmers. We had merely a few insignificant showers till away on to the last of September, so that grass and all forage crops were seriously affected. Hay was not half a crop, and grain in land not particularly rich in humus very poor indeed. We are exceedingly short of fodder, and the government is importing hay from Quebec to prevent the wholesale slaughter of cattle.'

A much brighter report comes from British Columbia, notwithstanding that large areas were affected by drought. Mr. J. R. Anderson reports grasses and clovers as giving 'good yields throughout the province, and on account of favourable weather hay was mostly well cured. Red clover, alfalfa, sainfoin and alsike in different localities gave some surprisingly large yields on irrigated lands, as much as three crops being cut in places. Timothy is largely grown, but its production is discouraged, as other grasses are preferable for pasture.'

Insect enemies of these crops were not complained of to any large extent; but this cannot be taken to mean that no injury was done. Enormous losses may be sustained in hay and fodder crops without farmers noticing the fact. Then, again, some losses have become so much a matter of every year occurrence that no mention is made of them in reports. This is particularly the case with the CLOVER-SEED MIDGE, to which I

have drawn attention very frequently. The annual loss at the present time is enormous, and yet, if those who grow clover seed practise the simple remedy of feeding off or mowing the first crop before June 20, the results are always so satisfactory that I cannot understand why the practice is not more generally adopted.

Mr. G. H. Clark, Chief of the Seed Division of the Department of Agriculture, who has exceptional opportunities of learning the condition of crops throughout the country, writes to me as follows:—

'Ottawa, Nov. 30.—Referring to your inquiry about the condition of the clover seed crop for 1904, I have to say that our instructor in seed-growing for the province of Ontario has reported that, on account of the severe winter, the crops of alsike and red clover in June and later months appeared patchy, and, in consequence, a much smaller area was left for seed crop than in previous years. Mr. Newman also inspected fields of red clover that had been left for seed in nearly all of the districts where red clover seed is extensively grown, and found in practically every county that the crops had been badly injured by the midge. These conditions, together with the unfavourable weather for ripening the seed, would indicate that the clover seed crop of 1904 will fall considerably below the average.'

Further efforts will be made next season to draw the attention of the clover seed growers to this important matter; and it is to be hoped that a reduction may be made in the great amount of loss which is now taking place every year. Letters appeared in the newspapers last year at the end of June, advising the best steps to take and a few farmers followed them; but the result of the clover seed harvest of this year is very unsatisfactory. The plants in many places suffered from the severity of last winter, and there was a great deal of winter-killed clover in spring. Alsike seems to have suffered even more than red and mammoth clovers, and red clover in all parts of the province of Ontario was injured by the midge. In travelling over part of New Brunswick and in the Annapolis valley of Nova Scotia in June last, I found red clover in almost every section badly attacked by the midge.

The Corn Worm (*Heliothis armiger,* Hbn.).—From time to time complaints are received from various parts of the country of more or less injury to sweet corn in autumn by the caterpillar of a noctuid moth, which is known by various popular names. It is what Professor Lugger called the Sweet Corn Moth, or Tassel Worm, in Minnesota, and is also the same as the notorious southern 'Boll Worm' of the cotton, to which crop it frequently does great damage and for which it has been found very difficult to find a practical remedy. The name of widest use is the Corn Worm, although its injuries in Canada are not confined to Indian corn, for the caterpillars have also been found boring into the fruit of tomatoes and attacking many other plants. There is but one brood in the year in Canada, the caterpillars occurring in autumn and the moths from these emerging the following summer. The worst injury by this insect in Canadian crops is to the cobs of sweet corn, because the work of the caterpillars renders the ears unsightly and discoloured so as to be unfit for the table.

In 1898 there was a bad attack at Orillia, Ont., when as much as 95 per cent of the ears of both sweet corn and yellow field corn were injured. There were other outbreaks in the same year in western Ontario and at Ottawa. These caterpillars do not appear till late in the season, generally during the months of September and October, when they may be found of all sizes, eating the young grains near the tips of the ears, frequently as many as five or six caterpillars working in the same ear. As they approach full growth, when they are an inch and a half in length, they frequently eat their way out of one ear and attack another one.

The only account of injury by the Corn Worm this year comes from Nova Scotia, and is the first record I have had of injury by it in that province.

'Mahone Bay, Sept. 7.—I send you under separate cover specimens of what is to us a new pest. It affects garden corn in the way you will see by the portions of seve-

ral ears I am also sending. There are from one to three of the caterpillars in each ear, and, of about 45 ears picked by me, so far only five were free from them. This pest seems quite general here, and at least for eight or ten miles around. One man only, of all I have asked about it, tells me that his corn is not affected. After a while the caterpillars make a round hole through the husk and disappear, I suppose, into the ground, although I have vainly hunted for them in the ground about the corn roots.' —Charles A. Hamilton.

The caterpillar is somewhat variable in colour, and is from one and a quarter to one and a half inches in length when full grown. The head is honey yellow, and the body varies in colour from pale greenish to dark brown, and is marked with longitudinal dark stripes and with a conspicuous band along the sides where the breathing pores are situated. This band is white, mottled with pink. On the body are the ordinary tubercles which are found on noctuid larvæ. These are distinct and black, each one bearing a slender bristle. The upper surface is marbled irregularly with white, and the whole surface of the skin has a velvety appearance, owing to numberless very short bristles, which are black and white in about equal numbers. A single specimen, which turned out to be a caterpillar of this moth, was found in a greenhouse late in the year (October 28). It was full grown and buried in the ground on October 31. The jar containing it was kept out of doors for the winter, and the moth emerged on July 8 the following year. This caterpillar was remarkably unlike those occurring on corn the same year, being entirely dark velvety green, without conspicuous markings, and was feeding on the leaves of a scarlet geranium. This moth, however, is by no means a common species in Canada, and nearly all of the specimens I have seen have been taken late in the year. Prof. Lugger states that the insect does not winter in Minnesota, but that all are killed late in the fall. This, he points out, would mean that the insect has to be reintroduced every summer from the south, where it can successfully hibernate. Whether the insect also hibernates as a moth in Canada, I have been unable to decide, but it certainly passes the winter in some instances as a pupa, although the caterpillars vary so much in size late in the year that many of them must be caught by early frost, which destroys their food plant. The moth of this insect is somewhat variable in the intensity of colour, but is usually of a dull pale ochreous yellow, with olive or ruddy markings on the forewings. The yellowish hind wings have a broad blackish band, and are edged with pink. These moths expand a little more than an inch and a half from tip to tip of the opened wings.

The caterpillars of the Corn Worm are recorded as having been found on a great many different kinds of plants, including the following crops: Pumpkins, tobacco, beans and peas; and the full grown caterpillars seem to have a penchant for eating into any solid firm object, such as a fruit or pod of any kind.

Remedies.—Unfortunately this is a very difficult insect to keep in check. When it attacks corn, as described above, it is seldom noticed until a considerable amount of harm has been done. Where the caterpillars are troublesome regularly every year, growers, it is claimed, get into the way of recognizing at a glance, ears which are infested, by the discoloration of the silk earlier than is natural in perfect ears. As soon as an infested ear is discovered, the leaves of the husk are pulled back and the caterpillars destroyed by hand. Where, as in Canada, it is only at long intervals that harm is done in any one place, corn growers are taken by surprise, and the injury is done before it is noticed. It is claimed that many of the moths may be taken in lantern traps consisting of a lamp standing in an open pan containing water with a little coal oil on the top of it. Anyone, therefore, who knew the appearance of the insect, upon recognizing the moths in years of great abundance flying around lights at night, might place lantern traps as described above in his crop, and thus prevent future loss; but this insect, like many others which appear in an intermittent manner, will always be a source of trouble. On fields where a crop of corn is known to have been attacked by the Corn Worm, the old stems should be removed from the field as

soon as the crop is gathered, and the land ploughed deeply in autumn so as to break up the cocoons and expose the pupæ to the weather and their various enemies among the small birds and mammals.

The Black Army Worm *(Noctua fennica,* Tausch.).—This cutworm was found in small numbers at Ottawa, chiefly in gardens and clover fields, but no great harm was done. There was a serious occurrence of the insect at St. Emile de Suffolk, Que. Mr. Elsimère Guérin wrote on May 27 : 'This spring I sowed 13 bushels of peas, which have been destroyed by the caterpillars of which I send you specimens. They are beginning to attack my oats. Can you tell me what I can sow in place of the peas without loss ? Also, if there is anything I can use to destroy the worms ?'

The samples sent were full grown specimens of the Black Army worm, which is a velvety black caterpillar with red head and legs and is striped down the back and sides with distinct but fine white lines. The dorsal area is sometimes more or less washed with a reddish tinge. There is a distinct white waved stigmatal band, washed with yellow and bearing in the centre an irregular black line. The lower side of the body of these caterpillars is a dusky green mottled with white. They become full grown about the end of May, when they burrow into the ground and turn to chrysalids, from which the moths emerge in July. In reply to Mr. Guérin's question, he was advised to leave the pea field and see if the plants did not recover, this having been our experience at Ottawa in 1891, when from a field similarly injured a heavy crop of peas was harvested. Later in the year Mr. Guérin wrote to me that he had reaped a heavy crop of peas from this field.

The Cottony Grass Scale *(Eriopeltis festucæ,* Fonsc.).—In the report of the Entomologist and Botanist for 1895, some account is given of a curious scale insect which has occasionally appeared in vast numbers in pastures and meadows in Nova Scotia and Prince Edward Island. From time to time specimens of the egg-sacks of this scale insect on grass (Plate I., fig. 4) are sent in for information, and apparently the species is not uncommon in the Maritime Provinces. During the past summer I observed small colonies in many places, and Mr. W. H. Harrington tells me that he also found them very abundant near Sydney, C.B. Mr. Charles Myers sent specimens from Lake Verd, P.E.I., with the statement that in many places, both in new meadows and on old sod, almost every blade of grass had one or more of the scales upon it.

This insect passes the winter in the egg condition beneath the scales. The young hatch in spring and feed on the leaves and stems of grass. The females become full grown in July, and towards the end of the month lay their eggs in conspicuous elongated oval sacks of closely felted downy white threads. As the eggs pass the winter upon the old grass, the burning over of pastures and meadows late in autumn or before growth begins in spring, would be an easy way of destroying this scale, should it at any time multiply so as to become injurious.

ROOTS AND VEGETABLES.

Both field and garden roots and vegetables have been to some extent affected by weather conditions in spring, and also have suffered considerably from well known enemies, but in most places they picked up well in autumn. Foremost among insect enemies were cutworms, which were extremely abundant and destructive in some parts of the Maritime Provinces, Ontario and the North-west Territories, and also in some places in British Columbia. The Turnip Flea-beetle did a great deal of harm in Nova Scotia, making it necessary sometimes to sow twice and even three times. Turnips

in fields as well as in gardens were much injured by the ordinary Cabbage Root Maggot. The Onion Maggot was destructive everywhere. Beets and mangels had their leaves somewhat blistered by the mining larvæ of the fly *Pegomyia bicolor*, Wied., reports being received both from western Ontario and Nova Scotia; little harm, however, was done, as the attack stopped early in the season. The Turnip Aphis, Cabbage Aphis and plant-lice upon several other vegetable crops were numerous and destructive.

Potatoes were in most districts a satisfactory crop. The Colorado Potato Beetle was less aggressive than for many years, and no new enemies of prime importance were reported. The Potato Aphis occurred at Mahone Bay, in Nova Scotia, and did some harm; but this is an insect which so far has only appeared at long intervals. The Potato Rot has been rather prevalent and destructive. In Prince Edward Island 'the root crops were good—potatoes never better nor less attacked by pests of any kind.' (Rev. A. E. Burke.) At the Provincial Exhibition held at Charlottetown in September last, the exhibit of potatoes was simply wonderful, the tubers being even in size and remarkably free of blemish. In Nova Scotia the crop was a good average one, with little mention of rot. In Ontario there was a large yield, but considerable rot appeared, especially on heavy soil or on low land; the extent of the loss is variously estimated at from 20 to 50 per cent. In British Columbia, Mr. J. R. Anderson says: 'Potatoes are decidedly under the average in those sections where the best qualities are produced; fair on low lands; prices firm. The yield of other root crops is about normal, but short in some of the higher regions, although the quality is good.'

Spraying potato fields with Bordeaux mixture to prevent injury by the Potato Rot has again shown the great value of this useful remedy. Four sprayings on August 1, 15, 31 and September 14, gave potatoes absolutely free of all traces of disease. This was on light sandy land, and, as a rule, one or two more sprayings would be advisable. The saving from this treatment for Potato Rot is now so well established and so many object lessons have been given at fall exhibitions and on the experimental farms, that it is a most remarkable thing that more farmers and others do not practise such a simple method of saving a large proportion of their crop. Although, as with every other remedy, there is a variation in the amount of protection, in every instance that has come under my notice, and these have been many since we began to spray potatoes on the experimental farms, to show farmers what an excellent remedy it is—it has been invariably shown that spraying potatoes with the Bordeaux mixture to prevent Potato Rot always pays. Every year such demonstration plots have been grown since 1891, and, besides this, the Horticulturist and Agriculturist now spray all their potatoes as an economic method of obtaining as big a crop as possible.

The Potato Scab, another fungous disease which frequently disfigures and lowers the market value of potatoes very much, was also reduced to a minimum by soaking the tubers used for seed, before sowing, in a solution of 8 ounces of commercial formalin and 15 gallons of water.

Cutworms.—The larvæ of several species of noctuid moths known collectively under the name of cutworms (Plate I., fig. 1), as usual, did a large amount of harm in gardens, as well as, in some instances, in fields. By far the greater part of the injury was done by the Red-backed Cutworm (*Paragrotis ochrogaster*, Gn.), which is one of the widest spread and most injurious cutworms we have in Canada, appearing every year in greater or lesser abundance. It is not always possible to determine the species which is reported upon, but in most instances mentioned below actual specimens were received:

I was informed when in Prince Edward Island recently that, in almost all parts of the Island, cutworms had been most destructive last spring. Father Burke says: 'They were never more plentiful than last year and did a great deal of damage to all crops. Your poison bran remedy seems dangerous to apply where there are birds, fowls and other domestic animals about.'

Mr. A. McNeill, Chief of the Fruit Division, Department of Agriculture, writes on July 27: 'During my last visit to Prince Edward Island, I saw in many places, particularly in Queen's County, most serious depredations by cutworms. Our July crop reports emphasize this and show that the root crops as well as garden truck have been almost completely destroyed by cutworms. I trust you will be able to think out some scheme to help farmers get rid of this enemy.'

Mr. Saxby Blair, Horticulturist at the Experimental Farm, Nappan, N.S., told me, when visiting the farm in June last, that this same cutworm had done a great deal of damage in his vegetable plots and in the flower beds. I advised him to use the poisoned bran remedy, and he now tells me that, as far as the cutworms are concerned, this was most satisfactory in checking them.

'Mahone Bay, N.S., June 28.—I send specimens of cutworms which are doing damage here. They cut off indiscriminately all kinds of vegetables. One of the specimens sent had just finished cutting off a potato stalk nearly half an inch in diameter. About ten per cent of my peas were taken, and other vegetables were injured. Some of my neighbours suffered somewhat more severely. These grubs, I notice, are becoming more common. Last year there were comparatively few, and the year before I saw none. Please tell me the species. I don't need other information as I find cutworms fully treated in your reports.'—C. A. Hamilton.

'Tignish, N.S., June 30.—Cutworms are doing much damage in this part of Cumberland County. In my garden, with the exception of potatoes and sweet corn, they have eaten nearly everything.'—G. E. Stopford.

'Northport, N.S., July 6.—The cutworms I am sending are destroying cabbages, mangels, beans, &c., and are a perfect pest. What can be done to prevent their still growing more plentiful another year and to put a stop to the damage they are doing now ?'—G. Brander.

'Forest Glen, N.B., July 1.—I send you specimens of grubs which have given us great trouble this spring in our garden. They eat off the bean stalks just as they come above the ground. After they had destroyed a great many of our early beans they attacked black currant and gooseberry bushes.'—J. Bleakney.

'Hartland, N.B., July 4.—I am very much troubled this year with insect pests. Many of my plants are being cut off by grubs, and the trouble is general in this neighbourhood. In my garden, only cauliflowers and cabbages are attacked; but, with my neighbours, beans and tomatoes are badly destroyed. One man lost half his beans. I see that you recommend mixing bran with Paris green and sweetened water, putting a little of this round the plants. Is there any possibility of the plants absorbing enough of the Paris green so placed to render them unsafe for food ?'—John Barnett.

'Batiscan Station, Que., July 8.—What can I do to destroy grubs that are eating up my onions, cabbages and other vegetables ?'—M. Sissons.

'Trenton, Ont., November 11.—The only instance of serious loss from insect enemies during the past season, which has come under my notice, was when I was at Coe Hill about midsummer. I learned of the almost total destruction of young cabbage plants early in the season by cutworms.'—John D. Evans.

'Calgary, Alta., June 20.—We are sending herewith some cutworms which are destroying all plants they come in contact with.'—Hole & Anderson.

'Blackfalds, Alta., July 8.—Cutworms are very bad here this year. They have even started to eat off stalks of the potatoes.'—E. Dalton Tipping.

At Ottawa there was again this year a veritable plague of cutworms. My assistant, Mr. Arthur Gibson, took notes upon some fields which had been treated to save the crops from cutworms; and his observations confirmed us in the belief that the poisoned bran remedy, which I have advised so widely during the last few years, was on the whole the most satisfactory way of stopping injury by cutworms, and is a practical remedy equally applicable for crops growing in fields as in gardens. Mr. Gibson found in a field of tobacco which was being rapidly destroyed, that, by the second day after the remedy was applied, the destruction of the plants stopped entirely, and dead

Fig. 1.—A cutworm and its moth.

Fig. 2.—The Plum Curculio : *a*, beetle ; *b*, pupa ; *c*, larva—natural size.

Fig. 3.—The Plum Curculio : beetle —enlarged.

Fig. 4.—The Cottony Grass Scale : egg-sacks on grass—natural size.

(Figs. 2 and 3 kindly lent by J. M. Stedman, Columbia, Mo. ; Fig. 6, by the N.H. Agr. Exp. Station.)

Fig. 5.—Apple infested by Apple Maggot.

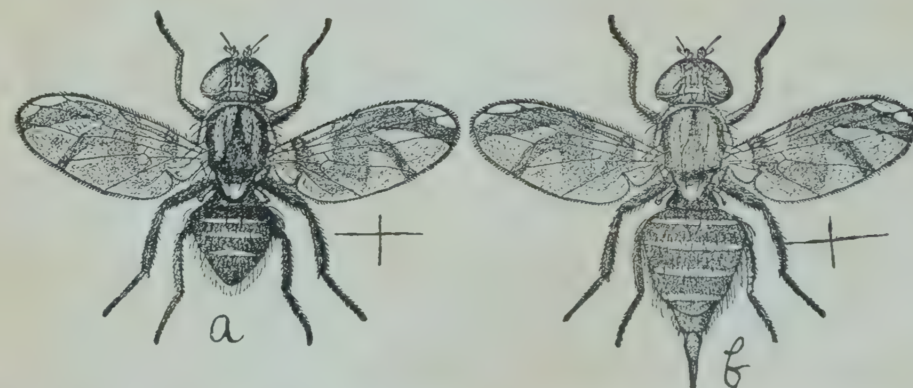

Fig. 6.—Flies of the Apple Maggot : *a*, male ; *b*, female—enlarged.

or dying cutworms could be found by moving the soil lightly beneath every plant. By actual count, as many as nineteen were found under a single plant, and nearly as many under several others. This is only one instance of the very remarkable effectiveness of this remedy.

Remedy.—The poisoned bran mash is made by mixing half a pound of Paris green with fifty pounds of slightly moistened bran. In making this, it is best first to dampen some of the bran slightly with water containing a little sugar. After mixing thoroughly, add the Paris green by dusting it on the surface and stirring all the time. We have found that when Paris green is added to perfectly dry bran, owing to its weight, it will sink at once to the bottom when stirred, in the same way that it does in water. Half a pound of Paris green is enough to poison fifty pounds of bran, although double this amount may be used. If the mixture is too wet, more dry bran should be stirred in until the mixture will crumble easily and run through the fingers without adhering.

When required for garden use, all that is necessary is to sprinkle a little of the poisoned mixture by hand around such plants as are liable to attack. When crops are planted in drills or in rows, a convenient way is to make the mixture almost dry and then distribute it by means of a Planet Junior or other wheel seeder. In field practice, among such close growing crops as standing grain, which are sometimes injured by the Red-backed Cutworm, the poisoned bran remedy is also serviceable. The mixture can be distributed by means of a paddle or shingle and can be thrown easily to a distance of twenty feet. When distributed in this way, there is much less danger of chickens and birds picking it up than if it is placed in lumps.

The question of danger from the use of this poisoned bait is one which must be considered. It is frequently inquired about by correspondents, and some instances of the poisoning of poultry where it has been used, seemed to be justly attributable to their having eaten some of it. As a rule, there is little danger from this cause. The quantity used is so small that it is not noticed by poultry; and then, in gardens, poultry do so much harm to plants that they should never be admitted, at the time of year when cutworms occur injuriously and only at special times of the year when there are no crops to injure. If, however, there should be a bad infestation by cutworms and there is no means of barring out or driving away the chickens, the owner of the crops must decide whether he will lose his crop or take special means of protecting his chickens. The experience of a great many people who have used this remedy without taking any special precautions, is that injury to domestic animals is extremely rare ; and, although I have been on the watch for any trouble of this sort for many years, I do not know of a single instance when poultry have been poisoned, without doubt by eating poisoned bran put out for cutworms. However, there will be many occasions when plants in gardens may be protected by putting out the poisoned bran in small heaps and then covering these up with a piece of shingle or some other covering, so that the material cannot be got at by stray chickens and other poultry.

It has also been asked whether there is any danger of plants absorbing Paris green from this mixture when placed near their roots. In reply to this, it is only necessary to point out that Paris green is practically insoluble and therefore cannot be absorbed by the plant.

Root Maggots.—These insects, which every year are a serious tax on market gardeners, were in 1904 particularly aggressive, and from every province frequent demands were made for a practical remedy. Radishes, cauliflowers, cabbages, turnips, onions, and, in a few instances, beans and sweet corn were injured. Only a few years ago there were many districts in the West where root maggots were unknown; but of late years these have been invaded. Bad infestations are reported by Mr. N. H. Holland, from Norquay, Man., who speaks of his success in growing onions in former years, but now finds that he has this year lost a third of his crop and says that the maggots are get-

ting worse every year. Loss is also reported from Regina, Moosejaw and Calgary, as well as from many places at the coast, in British Columbia. In the Ottawa district these maggots were particularly destructive, and on the Central Experimental Farm Onion Maggots worked actively throughout the season from the middle of June till November, when they were destroying the ripe bulbs. The Radish Maggot was abundant in spring, and again in September. Cabbages and cauliflowers which were kept free from these enemies till the middle of July, were not afterwards injured. This was probably due to the hardening of the stems and the abundant root growth. Beans planted late and too deep in the soil were moderately attacked, but this is an unusual injury. Only one instance of corn being injured came to my notice, and this was from the seed having lain in the land for a long time and growth being retarded by cold wet weather. Several remedies were experimented with, but no very satisfactory results were obtained, except in the case of plants grown under a light wooden frame covered with cheese cloth, such as was mentioned in my last report. Under these protections, however, radishes and cauliflowers of high quality were grown which were perfectly free from the attacks of the maggot. Onions were too much drawn up by the shade and did not bulb well. I found that a convenient covering of this nature 8 feet long by 2 feet wide, and 2 feet high, can be made for about 25 cents, the frame being of light one-and-a-half-inch square wood simply nailed together at the corners and with cheese cloth tacked on on the outside. In a frame of these dimensions five cauliflowers and two rows of radishes were grown. The frame was kept on from the time the seeds were sown until the radishes were pulled. Cauliflowers were sufficiently advanced to require no further protection, and the frames were removed about the 1st of August. As a rule, the attack of the root maggots becomes perceptibly less by the first of August; and even late cabbages planted in July are seldom attacked by root maggots. During the season of 1904, the insect in all stages could be found throughout the season.

For plants grown in the open, the best results this year were secured from the following remedies:—

For Onions.—White hellebore dusted along the rows once a week gave comparatively clean onions, very few being attacked. In years when it is necessary to apply the remedy throughout the season, this would be too expensive to be considered a practical remedy. The Cook carbolic wash, which is very effective for radishes, was less so with onions. Pyrethrum insect powder, Bug Death, Paris green and plaster, used as dry powders, had little effect. Sand saturated with coal oil and Jeyes' Gardeners' Friend, were also tried this year without any decided results in saving onions from attack.

For Cabbages.—The remedies which have given the best results for cabbages are: 1. The Goff tar paper disks, which are pieces of ordinary tarred building paper three inches in diameter, with a slit running to the centre so as to allow of their being placed around the stems of the young cabbages at the time of planting. 2. About half a teacupful of a decoction of pyrethrum insect powder, four ounces to a gallon of water, poured around the roots of each plant after drawing away the earth, right down to the rootlets. The earth should then be pushed back again and hilled up round the stem. As a substitute for pyrethrum insect powder, hellebore was tried this year, not only at the Central Experimental Farm, but also by Mr. Saxby Blair, the Horticulturist at the Experimental Farm for the Maritime Provinces, at Nappan, N.S.. The results were very satisfactory. Mr. Blair writes : 'The Cabbage Root Maggot gave us considerable trouble last year; but this season their numbers were much greater and they proved very destructive to all the plots of cabbages and cauliflowers except two. These were where hellebore was used. This remedy exceeded all my expectations, and no root maggots could be seen around any of the plants in these two plots; indeed, they were the only good cabbages out of some 1,500 set out. The powder was mixed with water and applied with a force pump; I used two ounces to the gallon and four ounces to the gallon, and found the results of the two ounces just as good as where

four were used. I am much pleased with this remedy, and, as far as one can judge from a single season, I am inclined to consider this a positive remedy for the root maggot of cabbages.'

Hellebore as a remedy for root magots was first recommended to me many years ago, about 1888, by Mr. S. Greenfield, a successful gardener of Ottawa East; and I have found that, as a rule, it is a useful remedy. At Ottawa this year, as in previous years of heavy infestation, it provided considerable protection, but was not as perfect a remedy as Mr. Blair found it at Nappan.

For Radishes.—The Cook carbolic wash, consisting of one quart of soft soap, or one pound of hard soap, in a gallon of water, with half a pint of crude carbolic acid added, and the whole boiled together for a few minutes, to make the stock emulsion, has proved over and over again an excellent remedy for radish maggots. The stock emulsion can be kept in a closed vessel, so that dust and rubbish will not fall into it; and, when required for use, one part of this mixture by measure is added to fifty of water, and should be sprayed directly upon the growing plants from the time they appear above the ground, once a week until ready for the table. Applications of nitrate of soda, kainit and potash whale-oil soap, all of which have been from time to time recommended, proved to be quite useless at Ottawa.

It must still be acknowledged that up to the present time we have not secured a practical remedy for root maggots on onions. For radishes, which are ready to pull from five to six weeks from the time the seed is sown, the question of protecting them is much simpler than in the case of onions, which are growing throughout the season. The maggots of the first brood are nearly full grown and very destructive about the end of June; and, in some years, if the plants can be protected from injury up to that time, they are as a rule safe for the rest of the season.

There are some features about this attack which make it of interest to the entomologist. Some experiments have seemed to indicate the great value of a certain remedy, and then under other conditions this same remedy has proved comparatively useless.

For next year extensive experiments have been planned, and special attention will be given to this matter, which is one of great importance, both to the professional and amateur gardener from one end of the country to the other. From the limited experience we have had with the cheese-cloth coverings, I have no hesitation in recommending these to amateur gardeners, however small their gardens may be, as a sure means of obtaining perfectly clean, as well as early, radishes and cauliflowers of the very best quality, at a comparatively light expense.

The Green Blister Beetle (*Cantharis cyanipennis*, Say).—Several kinds of blister beetles occasionally attack cultivated crops, and, unless driven off or poisoned, do much harm in an incredibly short time. Although in the larval state they are predaceous parasites feeding on the eggs of locusts, in the perfect condition they feed voraciously on vegetation. The Green Blister Beetle has not been previously sent in as a crop pest, but on June 15 last Mr. Richard Coates wrote from Cowley, Alta.:—'Enclosed you will find some insects which have come in numbers to my garden this year. They stay right with the beans and peas and soon destroy them.'

These beetles are long narrow insects, sometimes nearly an inch in length, of a most beautiful deep blue-green colour, which alight in large numbers and then may be noticed crawling quickly over the plants they are attacking and rapidly devouring the foliage. I have collected this species on the wild American vetch, at several places in western Assiniboia and southern Alberta.

Cabbage and Turnip Aphis (*Aphis brassicæ*, L.).—Reports of injury by this plant-louse have again this year been received from many and very distant localities. On the whole, however, I do not think it has been quite as destructive as usual.

'Victoria, B.C., November 1.—Aphides of various kinds were in evidence. Swedish turnips and cabbages suffered severely from their ravages.'—J. R. ANDERSON.

'Cowley, Alta., October 19.—My vegetable garden is covered this year with a grayish-green insect, something like the green fly that attacks house plants. They bega on the turnip tops, but now the Brussels sprouts are so covered that I cannot use them and I can only use the large heads of cabbage which are too firm for them to get inside the leaves. Most of the cauliflowers were unfit for use from the same cause.'—I W. GODSAL.

'Depot Harbor, Ont., September 12.—I send you samples of insects which ar destroying my turnips and cabbages. What are they and what is the cure?'—J. E PRATT.

Other Ontario occurrences which came to my notice were of fields moderately infested at Whitby and at Ottawa. There were a few reports from Quebec and from Prince Edward Island, and one from Mahone Bay, N.S.

The remedies are to watch for the beginning of the infestation when hoeing turnips and cabbages, and destroy the colonies either by spraying with kerosene emulsion or whale-oil soap, and the destruction or deep ploughing down of all turnip tops or refuse of cabbage beds in autumn, so as to destroy the eggs.

Although parasites are generally present in considerable numbers, they have not, as a rule, controlled this species so completely as is the case with many others. On the Ottawa fields, specimens of a parasite were present, which has been kindly identified by Dr. Ashmead, through Dr. Howard, as *Lipolexis (Aphidius) rapæ,* Curtis. Dr. Howard says:—'This is a European species evidently introduced. We have it also from Michigan.'

PLANT-LICE of various kinds were complained of on many kinds of vegetables a root crops during the past season. Dr. C. A. Hamilton, of Mahone Bay, N.S., favoured me with some interesting notes which he has made from time to time in locality during the past summer.

POTATO APHIS (*Nectarophora solanifolii,* Ashm.).—Potatoes are not often trouble with plant-lice in Canada; but at long intervals outbreaks have been observed on this crop, and such a one occurred last summer at Mahone Bay, which was closely watche by Dr. Hamilton.

'Mahone Bay, June 28.—I send you some aphides from potatoes. These are apparently the same species as is now on my salsify and are abundant enough to have appreciably blighted my potato plants.'

'July 10.—There seem to be aphides on almost everything this summer, probabl because of the abnormally dry season. Besides those sent, I noticed them to-day on squashes, cucumbers, broad beans, turnips, cabbages, beets and carrots, in fact, on almost everything I looked at.'

'July 14.—The aphis on my potatoes has overrun the whole patch, with the resul that the potatoes have stopped growing and look very unhealthy. The blossoms have withered up and fallen, the lower leaves have turned yellow, and many others have turned black, just as if smitten with the blight, and are falling. They occur in immense numbers. Their favourite position is upon the peduncles of the flowers, which they cover completely. They are also found in large clusters on the stems and upon the under surface of the leaves. In many colonies there are a few flesh-coloured individuals.

'July 15.—In *re* potato aphis, I to-day examined several plots near the village and found one field with about half the plants which had blossoms fairly well covered with aphis; other plants also had a few.

'July 16.—The plant-lice on the potatoes are fast diminishing in numbers; bu they have left the crop in a sorry condition.'

'August 1.—I send you to-day a last specimen from my potato plot. They have evidently been killed by a fungus. I first noticed its effects about a week ago on on

corner, and it has since spread over the whole piece. Very few aphides are left alive. Since I last wrote, I noticed larvæ of lady-bird beetles and of *Syrphus* flies; but neither of these nor anything else had much effect in reducing the numbers of the plant-lice until this disease appeared. A month ago my potatoes could not have looked more promising. To-day I tried them, and out of six average hills I got 17 tubers, of which two only were large enough to be marketed.'—C. A. HAMILTON.

Remedy.—Should this plant-louse again appear in large numbers, infested plants may be freed of them by spraying either with whale-oil soap solution, one pound to six gallons of water, or kerosene emulsion, one to nine. These remedies would also be effective against the Colorado Potato Beetle, the Four-lined Plant Bug, Leaf-hoppers, and probably all other insect pests likely to be found on potatoes. They would not, however, probably be of any use against the Potato Rot fungus for which the Bordeaux mixture is such a useful remedy.

Aphis on celery, carrots and parsnips (*Siphocoryne*, sp.).—Dr. Hamilton sent also some aphides which he had found on celery, carrots and parsnips. It is probable that there were only two species concerned, and that both of these occurred on celery. Plant-lice are very difficult insects to send alive by mail, and, when put in alcohol or other preservative fluids, they lose their colour so much that they are not very suitable for study unless the species is well known. I am sorry to say that, notwithstanding much trouble taken by Dr. Hamilton in sending them, the specimens did not arrive in very good condition. They were, however, referred to Dr. Howard, Chief of the United States Bureau of Entomology, who reports under date July 17: 'Mr. Pergande has examined your aphides and says that 1 and 2 are species of *Siphocoryne*, apparently undescribed. The specimens on potato and salsify were rotten, but they appear to be *Nectarophora solanifolii*.'* The two species of *Siphocoryne* referred to above were very different in appearance, and there seems to be little doubt that they are different species. The specific description of these, however, will have to be postponed until further material is available. I shall be obliged to any of my correspondents who may at any time find plant-lice on carrots, parsnips or celery, if they will forward them to me for study.

Injury to celery and parsnips by plant-lice I have never seen before; but the attack on carrots has come to my notice on two or three occasions previously, and has been one of considerable importance.

'Mahone Bay, June 28.—I send aphides from my celery, some have wings and some are without; but, as I always find them together, I take them to be the same species. The small wingless ones are extremely active, disappearing at a touch to the plant. This is the first time I have seen plant-lice on celery in the three years I have been raising that crop. Eight or ten days after I set out the young plants I found them swarming with these insects, and my neighbour's plants are the same. What I think are the same kind of plant-louse, I find also on near-by weeds, *Chenopodium album* and *Galeopsis tetrahit*. I had some carbolic acid and soap wash made up for root maggots. I gave them two sprayings with this and it cleared them out.'

'July 8.—I send a number of aphides with a few celery leaves, which I hope will reach you alive or at least in good condition for examination. It is very difficult to capture these, but by touching the plants with a piece of cotton batting they jump into it and become entangled. The specimens you ask for are in bottle No. 1. Bottle No. 2 contains another kind, I suppose, which are found rather sparsely on the under-side of the leaf. In one of my letters I said that I thought that these insects had been brought here from Halifax on plants obtained by a neighbour. I do not think this now, as I find them infesting the celery of another neighbour who raised his plants from seed and who lives over half a mile from either of us. When first noticed, the insects were very plentiful, the celery was only an inch or an inch and a half high,

*Dr. Ashmead's description of this aphis is to be found in 'Canadian Entomologist', vol. XIV., 1882, p. 92

but each leaflet bore from six to ten aphides. They were scattered promiscuously over the plant, not clustered in any way. I sprayed my celery three times at intervals of a few days with the carbolic wash mentioned on page 182 of your 1903 report, with the result that the insects disappeared entirely each time for a day or two, then reappeared, but in diminished numbers. Close observation to-day shows me that these plant-lice are on the celery bed, on the soil and plants of an adjacent salsify bed, one foot away, as well as a few upon beds of carrots; and they appear to be feeding on both of these latter plants. I cannot see that they have injured my celery very much, whatever they might have done, had they been left unchecked; still, they undoubtedly are feeding upon it, and perhaps the injury does not show, because the ground is very rich and the plants are well cared for. No. 2, however, whenever present, distorts the leaves, and, if present in larger numbers, would, I think, be very injurious.'

'July 10.—Aphides from Salsify : These are increasing very fast, and my plants are getting overrun, but you will notice that some of them are parasitized, having died and turned white. They are bound down to the leaf with a webby material which covers a small grub.'

'July 14.—Whitish fragments of dead aphides lying in abundance upon my carrot leaves and upon the ground beneath called my attention to them, and I found the new leaves had their petioles swarming with plant-lice. Although very plentiful, they do not yet seem to have done much harm. I find a few species of lady-bird beetles and some other predaceous parasites, of which I send you specimens. I have been more anxious for you to see these insects, because on looking over your reports I find no reference to either a potato or a carrot aphis.'

'July 15.—I find to-day that my parsnips are also infested by aphis. Please notice if these are not the same species as those on carrot; and those on potato look very much to me like those I sent you some time ago, which were found on salsify.'

'July 16.—The dark hopping aphis on celery has disappeared; but I send you more of the green ones from the underside of the leaves, with as many winged specimens as I can find. They have not been very plentiful on the celery, but seem to me very much like those from the carrots and parsnips. I find lady-bird larvæ very plentiful on my carrots to-day, and they are clearing off the aphides nicely. I have been much interested in watching these pests, and shall be obliged if you can send me the names of them : two from celery, one from parsnips, one from carrots, salsify, cabbage and potatoes.'—C. A. Hamilton.

'Antigonish, N.S., Sept. 7.—My celery has been infested by a green bug. I inclose specimens and should like to know what it is and how to get rid of it.'—F. H. Beals.

As stated above, there is still some doubt as to the exact identity of the species found on celery, carrots and parsnips. I shall, therefore, be glad to get specimens for further study.

The Red Turnip Beetle *(Entomoscelis adonidis,* Fab.).—In travelling through Manitoba and the North-west Territories in July last, I saw very few specimens of this beetle, which is sometimes a rather serious pest of cruciferous crops in the West; but some inquiries have been sent in as to its nature and habits.

'Edmonton, August 21.—Some gardens here are infested with a beetle somewhat like a lady-bird but bigger, which is bright red with black bars down its back and a spot on the collar, about three-eighths of an inch long by a quarter of an inch wide. This is doing some harm to radishes and turnips. In addition to this, some of the white turnips are terribly diseased this year.'—C. H. Stuart-Wade.

The same insect was written about from St. Lazare, Man., by Mr. Louis Worms, who says that the insect had appeared in his district, and had been the cause of a good deal of discussion among farmers as to whether or not it was the Colorado Potato Beetle. He speaks of the leaves of turnips being entirely eaten or cut up into rags, and also that a large number of the turnips had rotted.

Mr. Norman Criddle reports that 'The Red Turnip Beetle became rather troublesome last summer to cabbage, radishes, turnips and a few other garden plants. I noticed, too, that it had a preference for radishes in the seedling state. A few of these plants left to go to seed would, I think, make excellent traps for the beetles, and could be sprayed from time to time to destroy those which have gathered there.'

The PURPLE-BACKED CABBAGE WORM [*Evergestis (Pionea) straminalis*, Hbn.].—Occasional reports have been received at different times during the past ten years of the presence of short bristly caterpillars attacking cabbages and turnips in the Maritime Provinces. This injury was for the most part to turnips, and was generally noticed late in the season, the caterpillars congregating on the crowns of the turnips and eating cavities into the roots, as well as consuming the leaves. During the past season this caterpillar seems again to have been somewhat abundant, particularly on Cape Breton Island, whence Mr. E. J. Williams, of Little Bras d'Or, sent specimens, together with notes on the occurrence. He also reports that in some years whole fields of cabbage and turnips have been destroyed by these caterpillars. Among the specimens sent by Mr. Williams were a large number of half-grown larvæ of the Spotted Cutworm (*Noctua c-nigrum*, L.), which undoubtedly had been responsible for some of the injury described by him in the following note. Writing under date of October 24, he says:—'I am sending you some of the caterpillars I spoke of. They are very gregarious in their habits; they start under the leaves right on the ground but mine their way up to the head, tunnelling it hollow.'

In 1903 Mr. C. H. Young, of Ottawa, made some observations on injuries by this species upon cabbages near Old Chelsea, Quebec, twelve miles from Ottawa. The caterpillars, however, were not very numerous in this instance, and were not noticed to bore into the stems as mentioned above, but lay exposed on the leaves, and only two or three caterpillars were found on a single plant. Full-grown larvæ collected by Mr. Young on July 11 produced moths on August 8.

There is little reference to this species in the literature on injurious insects; but under the name of *Pionea eunusalis*, Walk., there is an account, with a good figure of the larva, by Thaddeus Harris in his Entomological Correspondence, page 322, stating that on October 30 and November 1, 1841, he had found larvæ on the leaves of horseradish. He thus describes the attack: 'They eat large holes out of leaves, leaving finally only the veins untouched. They live beneath the leaves, stretched out by the sides of the midrib. They creep regularly, not haltingly, and move pretty fast. When alarmed or disturbed, they curl quickly and loose their hold and fall to the ground. Found the same on turnip leaves, October 20, 1844. Their ravages were considerable.'

The Purple-backed Cabbage Worm is closely related to the Cabbage Pionea (*Evergestis rimosalis*, Gn.), which is a well known pest of the cabbage and turnip. That species, however, does not occur injuriously in Canada. The following is a description of the caterpillar, and is made from the specimens sent by Mr. Williams:—

Body tapering slightly to each end; length, three-quarters of an inch by one-eighth at the widest part; head, a shield divided into two spots on the second segment, and a small plate at the end of the body, black. The general colour of the back, purple with a brownish tinge, the lower part of the body, pale greenish. The body is marked with the ordinary bristle-bearing tubercles and a rather conspicuous yellow band on each side, where the breathing pores are placed. The six tubercles above the side lines are rather more conspicuous than those below the lines and are of a deeper black. The tubercles are all black, but have white marks at their bases, which form a part of an indistinct network of lines over the whole upper part of the body. These lines are broken up into dots, or seem to be narrow, broken, thread-like longitudinal lines connecting the tubercles in each series. There is also an equally indistinct line which runs transversely across the middle of each segment, and one in each intersegmental fold, the whole forming an open network composed of two series of very indistinct but perceptible lines running at right angles to each other. The chief character by

which this caterpillar will be recognized from that of the Cabbage Pionea, is that its head is shining black, while that of the last named is yellowish.

The moth of the Purple-backed Cabbage Worm is a very neat little species, which expands seven-eighths of an inch. The upper wings are of a strawy yellow with a satiny lustre, and are marked rather distinctly with a heart-shaped discal spot, two distinct transverse waved lines across the centre of the wing, the inner of which runs through the middle of the heart-shaped spot, and two less distinct lines, one at the base and the other close to the apex. There is also a conspicuous dark blotch bearing a white crescent outwardly, towards the apex of the wing. The spaces between the transverse lines, especially on the nervures, are powdered sparsely with brown scales. The lower wings are silvery white, with a clear, broad black margin and a narrow submarginal line inside this. The fringes of the upper wings gray, of secondaries white.

The full life history of this insect is not yet known; but it passes the winter as a chrysalis in a closely woven cocoon, to the outside of which many particles of earth are attached. The moth emerges in the spring, and there are probably two or three broods in the season.

FRUIT CROPS.

The conditions affecting the value of fruit crops in Canada during the past season are peculiar. The apple crop has not been particularly large in most districts, but was of exceptionally good quality. Early apples were abundant, but the markets were poo and 'thousands of bushels of fall apples remained unpicked or were fed to live stock.'—(Ont. Crop Rep., Nov., 1904.) Winter apples were rather short in quantity and, notwithstanding the quality, the present prices are low, owing to the enormous crop of high quality apples in Europe, which discouraged shipments and kept the fruit in our own markets, glutting them and holding down prices. There was an unusually poor plum crop almost everywhere, except in British Columbia, where it is reported 'plums and cherries were up to the average; large quantities were sent to the North-west, and good average returns were realized. Small fruits also gave our growers good returns this year; raspberries were a fair crop, blackberries good, strawberries yielded well, and those shipped to the North-west and Manitoba arrived in excellent condition.'—J. R. ANDERSON.

The excessive cold of last winter seems to have affected somewhat nearly all of our fruit crops this year. Apples are everywhere reported as rather small in size. Many varieties were severely killed back on the young wood. The same thing, and to a greater degree, is reported of pears; and this fruit was also injured by drought in British Columbia, and Black Spot and Fruit Crack in Ontario. Strawberry plants nearly everywhere suffered from winter-killing. The heaviest loss to fruit-growers from the winter was in the great destruction of the peach orchards in western Ontario, and in the orchards of Northern Spys and Baldwins throughout the country. Grapes were a fair crop, but where not sprayed, were considerably injured by Black Rot (*Læstadia Bidwelli,* V. & R.), the Brown Rot (*Peronospora viticola,* De Bary), and mildew.

Injurious insects were fortunately not very aggressive in 1904. There was, of course, as is always the case, a certain amount of damage done by the regularly occurring pests of the orchard, such as Tent Caterpillars, Cankerworms, the Eye-Spotted Budmoth, the Oyster-shell Scale, the Cherry Slug, the Imported Currant Sawfly, &c., for which standard remedies are available to all who wish to use them. These insects give no trouble in any properly looked after orchard, where the work is done syste-

matically at the proper time and with due regard to the true value of each operation, where regular cultivation and spraying are done as a matter of course, and not as an exceptional expedient which some unusual occurrence has made necessary.

Mr. A. McNeill, Chief of the Fruit Division of the Commissioner of Agriculture's Branch of the Department of Agriculture, has kindly allowed me to examine the reports from his correspondents all over the Dominion; and in this way I have been able to learn many useful facts concerning the condition of fruit crops and the insect and fungous enemies which have affected them during the year. Mr. McNeill writes as follows:—'Our crop reports this year furnished us with a large amount of material bearing upon fungous diseases and insects. On the whole, it may be said that these enemies did not do as much harm as usual. There were, however, several sections where the Apple Scab (Black Spot, *Fusicladium*) was particularly bad. One of these was the western peninsula of Ontario, where it was difficult to secure any clean fruit except in well sprayed orchards. A curious condition prevailed in the Annapolis and Cornwallis valleys of Nova Scotia. One part of the valley was particularly free from fungous diseases, while in another these were decidedly prevalent. There were no serious attacks of insects, and indeed the year 1904 may be said to have been remarkable for the absence of injury by the Codling Moth. This exemption, however, must not be counted on for the future, inasmuch as there were still sufficient insects to propagate the species; and, with favourable conditions, there is no reason why the Codling Moth should not be prevalent again next year.'

Mr. J. R. Anderson writes :—'Victoria, B.C., Nov. 1.—Apples were good, but the yield was only average. Prices ruled high, and those growers who put their product on the market in good shape realized well. Fruit-growing is receiving much greater attention, as it is better realized that, with that care which is due to every branch of agriculture, a very superior article can be produced, with a corresponding profit to the grower. An exhibit sent to England from British Columbia was awarded the highest gold medal of the Royal Horticultural Society. This alone has stimulated the planting of orchards to an unprecedented extent.'

'Wolfville, N.S.—We have been singularly free from injurious insects this year; but Cankerworms and Tent Caterpillars are both on the increase, and there has been some loss from Eye-spotted Bud-mouth and Cigar Case-bearer, the latter of which is especially common in Annapolis County.'—F. C. SEARS, *Horticulturist, Department of Agriculture, Nova Scotia.*

'Alberton, P.E.I.—Our apple crop is large and cleaner than for many years, even in unsprayed plantations. The Black Knot on plums and cherries, wild and domestic, was bad.'—Rev. A. E. BURKE.

The following occurrences of insects injurious to fruit crops, among others, have been brought to my notice during the season and have received attention from the officers of the Division.

The SAN JOSÉ SCALE (*Aspidiotus perniciosus*, Cmstk.).—It is satisfactory to be able again to report that no new infestations by this insect have been reported beyond the limits of the area already invaded in 1903. It is probable that during the severe winter of 1903-1904 a large proportion of the wintering scale insects was destroyed. Among reports received, the following is of considerable interest, as coming from one who is specially able to observe and draw correct conclusions. Mr. Geo. E. Fisher, of Freeman, Ont., writes on July 10 last as follows :—

'The past winter was so unusually severe that I have been much interested in examining the condition of the San José Scale, to learn if possible the effect of extreme cold on this insect. Mr. Davis, of this place, for the past two years, has prepared about 100 barrels of lime and sulphur wash each year, which has been used by the fruit-growers in the district with such good effect that there is really little opportunity for investigation. However, I found a spot where the scale had been for some time, and had not been treated. I made weekly visits to this orchard, beginning about the

middle of June. At that time most of the scale insects appeared to be dead, and, as I had found in my experiments, that the males were more easily killed by treating with various mixtures than the females, I hoped that the winter might have destroyed the males, and that there might be no breeding. The cold weather certainly reduced the scale very much indeed, only a small proportion being alive, and these developed slowly; but I find that some have reached maturity, and at the present time trees which last fall had a lot of live scale upon them, have larvæ in moderate quantity running on the twigs, some with new white cover scales just formed, and some which have reached the drab-coloured state. From what I saw in this orchard, I take it that breeding began about July 5 this year, or two weeks later than usual.'

Although the San José Scale has not spread beyond its former limits, there is still a heavy and destructive presence of this insect in the orchards within the infested area. As misstatements with regard to this matter have frequently appeared in newspapers and elsewhere, it may be well to again repeat that the only part of Canada where the San José Scale is found is in the Niagara Peninsula and in the counties along the north shore of the western end of Lake Erie. Every care is being exercised by the Honourable the Minister of Agriculture to prevent any fresh importation from outside countries. The fumigation stations at Vancouver, B.C., Winnipeg, Man., Windsor and Niagara Falls, Ont., St. John's, Que., and St. John, N.B., are kept open in charge of competent men, who unpack, fumigate with hydrocyanic acid gas, and promptly repack and send on, all nursery stock which comes into the country. The fumigation with hydrocyaic acid gas, of the strength and for the time the trees are submitted to it in the government stations, is perfectly certain to kill every scale insect upon them.

A rigorous watch has been kept on every kind of nursery stock which could possibly bring in fresh importations of the San José Scale; and I have again this year the greatest satisfaction in reporting that no single instance has been brought to my notice of living scales having been detected on trees which had passed through the fumigating houses. The superintendents at all of the stations have done their work carefully and well, and no well-founded complaints have been received from importers, either as to the slight delay which must occur while the stock is being treated, or as to any injury to the trees during the necessary unpacking, handling and repacking. Careful experiments have shown that the formula used at our federal fumigation stations is thoroughly effective in killing the San José Scale, and does not in any way injure the stock submitted to the gas. The formula used is one ounce of cyanide of potassium (98 per cent), one ounce of commercial sulphuric acid (66° Baumé), and three ounces of water—exposure, 45 minutes.

In addition to the above, the provincial government of Ontario have strictly enforced an Act compelling nurserymen to fumigate every shrub and tree sent out by them from their nurseries, whether the San José Scale had been found in their nurseries or not. These firms have, wisely, acted well up to the letter of the law, and, while complying with the provisions of the Act, by sending out only first-class stock, have sustained their business reputation in the best way possible.

The federal fumigation houses are kept open, with a superintendent constantly in attendance throughout the seasons of spring and autumn shipments of stock. The fumigation seasons for the various stations are as follows:—

Vancouver, B.C.—October 15 till May 1.
Winnipeg, Man.—March 15 till May 15, and October 7 till December 7.
Windsor, Ont.—March 15 till May 15, and September 26 till December 7.
Niagara Falls, Ont.—March 15 till May 15, and September 26 till December 7.
St. John's, Que.—March 15 till May 15, and September 26 till December 7.
St. John, N.B.—March 15 till May 15, and October 7 till December 7.

The San José Scale Act and the amendments which have from time to time been made, are the result of an effort on the part of the Honourable the Minister of Agri-

culture to help the fruit-growers of the Dominion by allowing them to import nursery stock of such new kinds of fruits as from time to time are originated outside of Canada, and which it is claimed by fruit-growers are necessary for the profitable prosecution of their business, but at the same time, to safeguard their interests in every possible way by taking such precautions as would make it practically impossible for any new infestation of the San José Scale to be brought into the country with the nursery stock. The whole expense of the different stations is assumed by the Dominion Government; but all shipments are made entirely at the risk of the shippers or consignees, the government assuming no risk whatever. The packages must be addressed by the shippers so as to enter Canada at one of the above-named ports of entry, and the route by which they are to be shipped must be clearly stated upon each package.

Many horticulturists and nurserymen have availed themselves largely of this concession, and at every point much stock has been imported from the United States and Japan. Nursery stock of all kinds can be imported from Europe without fumigation, as the San José Scale has never gained a foothold in European countries. Certain other plants which are not liable to the attack of the San José Scale are also exempted from treatment under the San José Scale Act. These are: (1) greenhouse plants, including roses in leaf which have been propagated under glass; (2) herbaceous perennials, including strawberry plants; (3) herbaceous bedding plants; (4) all conifers; (5) bulbs and tubers; (6) cottonwood (*Populus monilifera*), grown in Minnesota and the Dakotas.

Remedy.—Frequent inquiries are made as to whether there is a practical remedy for the San José Scale. I believe that it may now be justly claimed that the lime and sulphur wash made by any of the recognized formulæ is a reliable remedy for this insect. Orchards which have been carefully treated, are in better condition than they were at this time last year, and have borne during the past summer satisfactory and profitable crops of fruit. No remedy, however perfect it may be, will give good results unless great care is taken in applying it; and even with the lime and sulphur wash, it is not claimed that a single application will always give perfect results. Any remedy which does not cost too much for labour and materials, and which will ensure a paying crop, is certainly a practical remedy. All remedies will vary in the degree to which they secure the ends aimed at, and all that is claimed for the lime and sulphur wash for the San José Scale, is that up to the present, all things considered, this has proved the best remedy, and is, at any rate, as successful in its results as any known remedy which is used in medicine for controlling the diseases of animals or human beings. Success with any remedial treatment will necessarily always depend on the thoroughness with which it is carried out.

The making of the Lime and Sulphur wash is described with full details in my last report.

The Canadian wash is made by mixing lime and sulphur together in the proportion of twice as much lime as sulphur, and boiling these together in an iron kettle for two hours (or not less than one hour). The quantity of water added to make up the required amount of wash is largely a matter of convenience in using. When boiled with steam, barrels may be used, and to begin with, should be one-quarter filled with water and the steam turned on until the water is boiling; then turn off the steam and put in the lime and sulphur together as quickly as this can be done without making the mixture boil over. When the lime is all slaked, turn on the steam again, and leave the mixture boiling for at least an hour. In Mr. Geo. E. Fisher's outfit, which has been frequently described and has been figured more than once, eight barrels of wash were cooked at once, and he found that with steam at 80 or 90 lbs. pressure, the quarter barrels of water, before the lime and sulphur were turned in, could be brought to a boil in five minutes. Mr. Fisher secured the best results when each gallon of the wash contained one pound of lime and half a pound of sulphur.

The Oregon wash consists of lime 15 pounds, sulphur 15 pounds, blue vitriol 1¼ pounds. Dissolve the lime and sulphur by boiling for one hour, then add the blue

vitriol dissolved in hot water, and boil for fifteen minutes longer; fill up to 50 imperial gallons.

The California wash consists of lime 15 pounds, sulphur 15 pounds, salt 15 pounds, water 50 imperial gallons.

The Lime-Sulphur-Soda wash consists of lime 40 pounds, sulphur 20 pounds, caustic soda 5 pounds. In making, the 40 pounds of lime is placed in a barrel, and only enough water is added to make it boil rapidly. While slaking, 20 pounds ground sulphur, which has been made into a thin paste, is stirred in thoroughly; the five pounds of caustic soda dissolved in hot water is then poured in, with more water as needed, and the whole is kept stirred thoroughly all the time. As soon as all chemical action ceases, as shown by the absence of bubbling in the mixture, add hot water up to 60 gallons, and the wash is ready for use. The whole time necessary is twenty minutes.

Dr. E. P. Felt, the State Entomologist of New York State, has made a further modification in this formula, by which he substitutes ordinary washing soda for caustic soda and has secured equally good results.

In all of the above mixtures, it is best to use hot water, and to have the sulphur powdered so as to help the rapid combination of the constituents.

The lime and sulphur mixtures must only be used as winter washes while the trees are dormant, or the trees will be injured. The best time is late in spring, just before the buds expand. If necessary, they may be followed in summer by applications of whale-oil soap solution, one pound to six gallons of water, or kerosene emulsion in the dilution of one part in nine of water.

Plum Aphis (*Aphis prunifolii,* Fitch).—The Plum Aphis was found rather abundantly on plum trees in Prince Edward Island, and Mr. Saxby Blair found it also troublesome in the orchards at Nappan, N.S. He writes: 'The pests that have worried me most are the plum and apple aphides. They are perfect nuisances. I thought I had them all controlled this year by early spraying, twice with whale-oil soap, one to six, but later on they appeared in myriads on some of the trees. It seems almost impossible to get men to spray their trees thoroughly enough to get at all of the plant-lice. Any information you can give about Plum Aphis will be useful to our fruit-growers; for this insect is becoming a general pest. Another thing is this: you advise whale-oil soap; now the average farmer in this country cannot get whale-oil soap. I tried to get some in this locality last summer, and they wanted 20 cents a pound for what they called whale-oil soap. If you can give in your report definite information where this soap can be procured, and what the usual price is, it would help. Could you not give instructions by which it could be made by the farmers themselves? I must say I find the whale-oil soap much easier and more convenient to use than bothering with tobacco water. Tobacco stems in most places are very difficult to get; but if whale-oil soap is just as good and can be got easily, that is what the average man will use. I find, too, that it takes much more liquid to do thorough work with tobacco wash than with a strong solution of soap.'

Remedies.—The standard remedies for plant-lice are soap washes and kerosene emulsion. Strange as it may seem, dark-coloured species of plant-lice certainly require stronger applications than the green kinds.

Kerosene emulsion in the dilution of one part to six of the stock emulsion has given good results against all kinds of aphides.

Soaps.—The most effective soap wash is made with whale-oil soap, one pound to from four to six gallons of water. The term whale-oil soap is merely a trade name for a fish oil soap, made with either potash or soda. The potash soaps, which are the best, because even strong solutions remain liquid when they cool, are soft soaps. The soda soaps are hard. Of the two the potash soaps are considered the best to use on vegetation, and they are more convenient to use. Both kinds should always be dissolved in hot water.

When bought at retail prices these soaps cost from 15 to 20 cents per pound, according to the locality, but, if obtained in large quantities, can be got at from 3 to 5 cents per pound. Fifty pound kegs are supplied at 5 cents per pound. Two well known brands of potash soft soaps which have been much used in Canada and have given good satisfaction, are those made by W. H. Owen, of Port Clinton, Ohio, and by Good & Co., of Philadelphia, Pa. If thought desirable, these soaps can be made at home; but it is very unpleasant and dirty work, and it is besides doubtful whether such good or cheap results can be secured as by buying from firms which make a special business of manufacturing soaps with only the required amount of moisture and the proper grade and amount of potash. It has been found in experiments carried on at Washington that what is required for spraying purposes is a caustic potash and fish oil soap, made with a fairly good quality of fish oil and from which water has been eliminated by boiling, so that it does not exceed 25 or 30 per cent of the weight of the soap. Soaps made with caustic soda instead of caustic potash are unsuitable for spraying purposes. Dr. J. B. Smith, in his circular No. 5, 'Whale Oil Soap and its Uses,' says: 'Whale oil or fish oil soap is one of the most reliable materials for use against plant-lice, and generally against sucking insects which can be killed by contact insecticides. It kills by clogging the spiracles or breathing pores of the insects and also to some extent by its corrosive action. The advantages of fish oil over ordinary laundry soap lie in the greater penetrating power, in the fact that it remains liquid when cold at much greater strengths, and that fish oil itself seems to be more fatal to insect life than other animal fats. A good soap can be made as follows:—

Concentrated potash lye	3½ lbs.
Water	7½ gallons.
Fish oil	1 gallon.

Dissolve the lye in boiling water, and to the boiling solution add the fish oil; continue to boil for two hours, and then allow to cool. Any grade of fish oil will answer.'

The PLUM CURCULIO *(Conotrachelus nenuphar,* Herbst.).—The Plum Curculio made serious inroads into the sparse crop of plums of 1904. It was complained of in all localities east of and including Ontario, and was perhaps the fruit pest most mentioned by correspondents. Plums, apricots, cherries and apples were injured.

The injury of the Plum Curculio is known by sight by thousands of fruit-growers who have never seen the beetle to recognize it as the cause of the injury which they know so well on their fruit. The beetle itself (Plate I., figs. 2*a* and 3) is less than one-fourth of an inch in length, brown and rough, with black and gray mottlings, which give it a remarkable resemblance to a small piece of bark, and make it very difficult to distinguish. There is only one brood of this insect in the year; but perfect insects may be found at all times, because the beetles which emerge during August or September of one year, pass the winter as perfect insects under dead leaves, &c., and feed on the buds and leaves of plum trees early in the spring, and later during the season on leaves and fruit of various kinds; the old insects of the year before may often be collected at the same time as the newly emerged brood. When plums are about as large as pease, the crescent-shaped slit, with a small flap containing the egg, may be seen upon them. The egg hatches soon after, and the white grub (Plate I., fig. 2*c*) bores into the fruit, so that in the case of the plums they soon fall from the tree. The peach, apricot, cherry, apples and pears are also injured, but do not fall from the trees to nearly the same extent as plums. A great many more of the larvæ of the Plum Curculio come to full growth in plums than in the other fruits ; the rotting of the fruit seems to be necessary for these grubs to mature. There is no doubt that by far a larger number of the grubs become beetles when they have fed in plums and cherries than in any other fruit. In apples, to which it causes serious injury also, from the disfiguring of the fruit, very few larvæ mature. By midsummer the larvæ are full grown and burrow a short distance into the ground, where they turn to pupæ, and the adult beetles emerge in August.

Apples badly disfigured were sent by Mr. C. L. Stephens, from Orillia, Ont., and similar samples were also received from two or three localities in Quebec province.

Remedies.—The remedies for the Plum Curculio are as follows : (1.) Spraying the trees early in the season so as to destroy the beetles which for some time feed upon the buds and opening leaves of plum trees. The second spraying, with poisoned Bordeaux mixture, should be made when the plums are about as large as pease. This will coat the young fruit so that the beetles are destroyed when they feed on the fruit or cut the crescents for egg laying. (2.) The destruction of all windfalls or injured fruit that drops, so as to clear away all fruit before the larvæ emerge and enter the ground to pupate. Poultry, pigs and sheep help well in this work. (3) The ploughing up and cultivation of orchards so as to remove grass and other vegetation which, besides weakening the trees, gives places for the insects to hide in. The depth at which the larvæ pupate is about an inch beneath the surface, and the pupation in this part of Canada takes place during July ; therefore cultivation during that month will destroy many of the pupæ, and this has been found the remedy which has given the best results in old orchards which had been in sod for many years and in which the fruit had been seriously injured year after year. (4.) The jarring of plum trees, which is much written about and highly recommended, will certainly destroy many of the beetles, but costs too much for labour when compared with spraying with insecticides, which give more certain results in my experience. As the plum and peach are rather easily injured by some arsenical poisons, arsenate of lead, 1 lb. to 50 gallons, is preferable to Paris green for these trees.

The Apple Maggot (*Trypeta pomonella,* Walsh).—The Apple Maggot has never done much harm in Canada, although its injuries are very serious in the apple orchards of Main and some other States adjoining our borders. The slender white maggots, about a quarter of an inch in length, burrow in all directions through the flesh of attacked apples, feeding upon the pulp and leaving discoloured channels (Plate I., fig. 5). There are sometimes as many as a dozen maggots in a single apple, but even one is sufficient to render it worthless. The eggs are inserted beneath the skin of the fruit by beautifully marked black and white flies, with shining greenish golden eyes. The general appearance of the fly is shown in Plate I., fig. 6. In size it is about half as large as the ordinary house fly. There is only one brood in the year, and the eggs are inserted into the fruit by the females with a sharp ovipositor. Egg-laying takes place from the beginning of July until autumn. The young maggots become full grown in about six weeks, and their work, as a rule, causes the fruit to ripen prematurely and fall to the ground, when the maggots work their way out and enter the soil for a short distance, where they change to pale-coloured puparia, but inside which they remain as maggots until the following spring The pupa forms only a few days before the perfect insects appear the next summer. The maggots of late-laid eggs are frequently in the fruit at the time it is picked, and these develop, destroying the fruit more and more as they grow. Apples apparently sound when gathered may, by the presence of eggs or young larvæ, afterwards become perfectly useless. The development of the maggot is slower in late and hard fruits.

In September last I received from Mr. R. W. Shepherd, the well known apple shipper, of Como, Que., samples of infested Fameuse apples, with the following information:—

'Montreal, Que., September 26.—I mail you to-day specimens of Fameuse apples taken from one of my orchards, an old one, which show serious blemishes. There is some disease unknown to me which has affected some of the Fameuse trees in that orchard. The outside skin of the apples shows dents, and, when the apple is cut open, there are brown punky spots in the flesh; the fruit is generally undersized, and in any case is practically worthless for sale. No other varieties are affected here, as far as I have been able to learn; but there are some other orchards which are suffering in a similar way to my own.

'October 10.—It is only my old orchard, which has been replanted at different times, that is badly affected. I have pigs there eating up the fallen fruit. I do not notice the maggots affecting any other variety than Fameuse, and in that orchard there are St. Lawrence, McIntosh Red, Scott's Winter, and other varieties. I noticed this injury last year for the first time, when the Shiawassee Beauty was affected. At that time I thought it was a fungus affecting the inside of the apple.

'October 20.—I am glad it was right to put pigs in the orchard; and, as they do not eat up the apples fast enough, I have given instructions that a herd of cows should be put in every day to make sure that all the fallen apples are done away with.'—R. W. SHEPHERD.

'Como, Que., October 25.—I thank you very much for your annual report. I am glad to have it, and hope to profit by your suggestions. Last year was the first time we noticed the Apple Maggot in our fruit; but it has increased a good deal this year. The McIntosh Red does not seem to have been troubled like the Fameuse, but Russets have.'—M. L. GIBB.

In addition to the above occurrence, apples from St. Hilaire, another celebrated locality for the production of first-class Fameuse apples, showed slight infestation. Como is thirty miles west of Montreal, and St. Hilaire twenty-three miles east.

Early and subacid varieties of apples seem to be preferred; but all varieties are said to be liable to attack, including late and winter varieties. When the late varieties are infested, the maggots do not emerge until some time during the winter after the fruit has been stored, the larvæ emerging and the pupæ forming inside the barrels or bins. The destruction of these pupæ and of all fruit when it falls to the ground during the summer and autumn constitutes the most reliable remedy for this injurious insect. The fallen fruit may be collected by children and fed to stock; or sheep and swine may be turned into the orchard from about the middle of July. Poultry will destroy many of the maggots and puparia beneath the trees. Late autumn ploughing will throw up many of the puparia to the surface of the soil, where they will be destroyed by birds, &c. Although the Apple Maggot has never done very much harm in Canada, the losses in Vermont, Maine and parts of New York State are sometimes extensive, occasionally amounting to 50 per cent of the fruit; and, as the injury does not show much on the outside, the uncertainty as to whether fruit is attacked or not renders it useless for sale. It may be well to point out here that, as the egg is inserted beneath the skin of the apple by the female fly, spraying with arsenical mixtures is quite useless as a remedy for this insect.

CODLING MOTH (*Carpocapsa pomonella*, L.).—One of the striking characteristics of the season of 1904 is the absence of injury by the Codling Moth, and this seems to be the case in all the fruit-growing districts of the country. I fear that this state of affairs may have an injurious effect by inducing many to give up spraying their orchards for the control of this pest. The absence of the Black Spot disease of the apple in 1903 had just this result during the past season. In some orchards which were free from disease in 1903, no spraying was done this year, and, as a consequence, what might have been beautiful crops have been ruined. Fungous diseases, although not caused by climatic conditions, are checked or developed enormously in accordance with favourable weather conditions or the reverse. The fruit-grower who is a good business man, has learnt before this that there is no longer any question as to whether spraying pays or not. That it does, is manifest every year by the predominant excellence of the fruit from all orchards which are sprayed, both as to insect presence and as to injury by fungous diseases. Mr. R. W. Shepherd, of Como, Que., and other buyers of the very best apples for the European market, assure me that, when purchasing the high quality fruit they require for that purpose, they cannot afford to waste time even in looking at orchards which have not been sprayed.

Although the Codling Moth was less destructive than usual this year, the presence of the eggs on apples and of the larvæ in fruit could be detected if closely looked for.

The weather throughout the past season has been such that insect occurrence of all kinds has been markedly less than has been the case for the last thirty years, so that the small numbers of the Codling Moth larvæ seen this year must not be taken as an indication that this most injurious enemy of the apple has disappeared to such an extent that spraying for it is no longer necessary. Moreover, it must be remembered that, by spraying apple trees at the times advised, viz., just when the buds are bursting and once a fortnight for two months afterwards, not only is the Codling Moth kept in check to the extent of saving an average of from 75 to nearly 100 per cent of the fruit, from its ravages, but also a great many other insects as well as fungous diseases are destroyed, giving the fruit-grower an enormous profit, compared with the cost of spraying.

Green Fruit Worm (*Xylina*, sp.).—When examining orchards at Gagetown in New Brunswick, as well as in the Annapolis Valley and other places in Nova Scotia in June last, I frequently came upon the larvæ of a *Xylina*. These caterpillars, of which there are many species very similar in appearance, are known by the name of Green Fruit Worms, and have the habit of gnawing large cavities in the sides of apples, as well as devouring the foliage. The perfect moths from these caterpillars emerge in the autumn, and after passing the winter as such, lay their eggs on the trees in spring. The best remedy is the regular spraying of fruit trees with the poisoned Bordeaux mixture.

The Red-humped Caterpillar (*Schizura concinna*, S. & A.).—This caterpillar feeds upon a great many different kinds of trees besides the apple, and is seldom destructive except upon young trees. The eggs are laid in clusters, and the caterpillars are gregarious throughout their lives. Mr. E. P. Venables, of Vernon, B.C., reports that they were numerous in his locality last summer and did much damage in young orchards, in many cases the whole foliage being stripped from infested trees. He detected a hymenopterous parasite which was doing good, and is now rearing specimens so as to learn the identity of this useful insect.

The Shot Borer (*Xyleborus dispar*, Fab.).—There were several complaints from fruit-growers in the Annapolis Valley, N.S., of injury to apple and plum trees by the small wood boring beetle, which has received the name of the Shot Borer (Plate II, fig. 7). There has not been much complaint concerning this insect since 1897, but last spring its work was noticed in many places in the above district. The attack consists of a small black burrow (Plate II, fig. 8), beginning generally at a bud and running right round the stem inside the wood and near the bark of young living trees. Inside this there is often another burrow, and then a short perpendicular shaft at right angles running down the centre of the twig or branch. There is variation in the nature of the tunnels, according to the size of that part of the tree where they are located ; but they are always about one-sixteenth of an inch in diameter, and if in a small branch or stem form a circular gallery with an ascending or descending perpendicular shaft, which serves as a brood chamber. When, as is sometimes the case, they occur in trunks of young trees of moderate size, from 4 to 6 inches in diameter, the galleries are straighter and simpler. These galleries are the homes and breeding chambers of the larvæ and their mother; for, although this insect is the cause of much injury to trees, with the exception of the wood which is gnawed out to make the tunnels, the tissues of the wood are not eaten either by the mature beetles or the larvæ; but the tunnels form caves within which a special kind of fungus is cultivated by the beetles as food for the larvæ, which simply lie in a small cell and feed or are fed by their parents on the fungus as it grows. An account of these beetles and their method of feeding upon the 'ambrosia' is most delightfully described by the late H. G. Hubbard, in an article entitled 'The Ambrosia Beetles of the United States,' one of the most charming narratives to be found in the literature of Economic Entomology. (See Bulletin No. 7, n.s., U. S. Division of Entomology.)

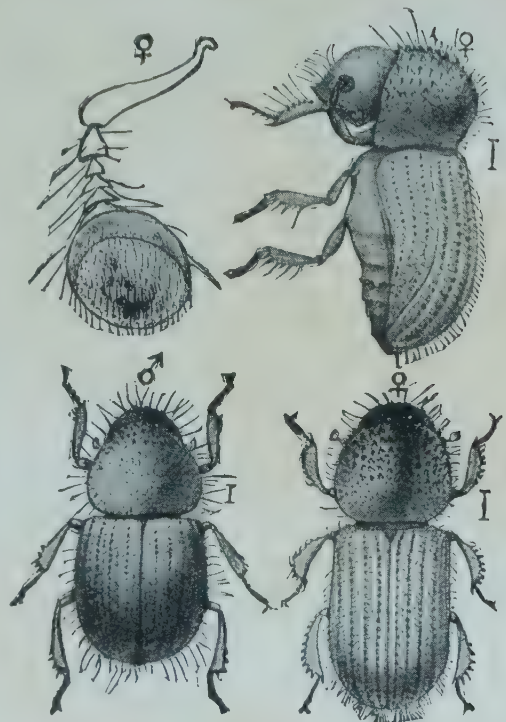

Fig. 7.—Shot-borer: ♂ male; ♀ ♀ female—enlarged; antenna of female—more enlarged. (*Figs. 7 and 8 from H. G. Hubbard, U.S. Dept. of Agriculture.*)

Fig. 8.—Gallery of Shot-borer in twig, cut across and lengthwise.

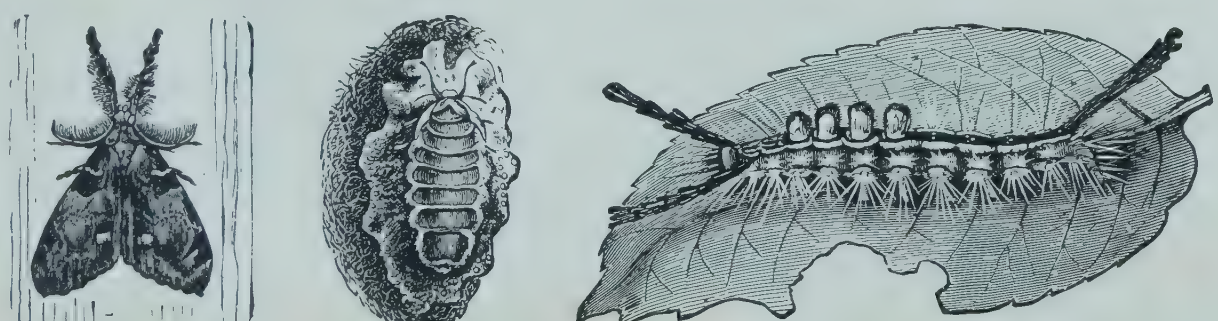

Fig. 9.—The White-marked Tussock-Moth: male, female and caterpillar.

Fig. 10.—Branch of Canada Balsam Fir, with roots from base covered by sand. (*Photo. by F. T. Shutt.*)

The remedies for this insect aim at either filling up the entrances to the holes in which the broods are being reared, so as to suffocate the larvæ, or in applying some liquid which will penetrate and destroy the fungous food or the larvæ and mature beetles while in the holes. For this purpose, kerosene oil and carbolic washes have been used with success; crude petroleum could probably be used with even greater effect, as on account of its extreme subtility it would penetrate the burrows more deeply than most liquids, and also would act as a deterrent wash which would keep the mature beetles away from the trees when seeking places to make their breeding burrows.

The carbolic wash which has given good results in Nova Scotia is soft soap, 1 gallon, water 3 gallons, crude carbolic acid ½ pint; the trees to be washed two or three times when the beetles are known to be prevalent. A difficulty with this insect will be found in the intermittent nature of its occurrence. As it is pretty sure to be present in some numbers in the same orchards where it was troublesome last spring, it will be wise for the owners to spray or wash their trees with a deterrent wash next season. Trees noticed to be badly infested at the time of winter pruning should be cut out and burnt before the beetles appear in spring, unless considered to be of special value, when they may be treated.

The Black Vine Weevil (*Otiorhynchus sulcatus*, Fab.).—This weevil seems to have become a regularly occurring pest in gardens around Victoria and some other places on Vancouver Island, and also near New Westminister and Vancouver on the mainland. It is a black snout-beetle, three-tenths of an inch in length, of a dull black, the wing cases being deeply grooved and spotted with fine white points. The grubs are yellowish white, with dark heads, and have the body somewhat curved; they feed on the roots of several kinds of plants. These beetles have no true wings and the two wing-covers are connate or joined together in the middle, so their only means of spreading from place to place is by crawling. The beetle occurs near the coast on both sides of the continent and is sometimes a destructive pest in strawberry beds in Nova Scotia and British Columbia. The plants which have been reported to me as injured by the Black Vine Weevil in Canada do not include the grape vine; the name Black Vine Weevil is taken from European publications, where it is the recognized popular name, and will answer here until a better is suggested. The grubs probably do more harm than the adult weevils and have been found attacking the roots of Cyclamens and other plants in greenhouses, particularly Gloxinias, Primulas and Maiden-hair ferns. The most important injury so far recorded against this weevil is of its attacks upon strawberry beds. Mr. J. R. Anderson, reporting on the insects of the season, says 'the Black Vine Weevil did a considerable amount of injury to strawberry beds. This was principally on the lower Fraser. It also attacked the roots of Primroses in some localities.'

'New Westminster, B.C., May 30.—The Strawberry Weevil (*Otiorhynchus sulcatus*) is very bad in several places this spring, and I find that in every case where strawberries are infested, they have been planted on land where the sod had been turned in previously, and that in neighbouring patches where no sod had been turned in they are comparatively few.'—W. D. Dashwood-Jones.

'Victoria, B.C., May 30.—I send you specimens of larvæ and pupæ of an insect which is in large numbers in a strawberry bed at Esquimalt, near here. I take these to be *Otiorhynchus sulcatus*; am I right? There are many complaints of injury to strawberry plants this spring from this or a similar pest, chiefly along the Fraser at Hammond, Haney and Mission, but also in the Victoria district.'

'June 13.—I will send you further specimens of *O. sulcatus* from Mr. Fleming's garden near Victoria, and I will also try and get you other specimens from the lower mainland, where by the bye, I am told by Mr. Cunningham that there are two distinct species of weevils infesting strawberry plantations.'

'June 20.—I send you a box containing specimens of weevils, principally in the pupal form, but also including some beetles which were taken from strawberry fields

at Hammond. You will see that there are two species, one much smaller than t other. From the appearance of the infested plants, I take the larger specimens to either *Tyloderma fragariæ,* or *T. foveolatum.* Will you kindly identify and sugge remedial measures?'—R. M. PALMER.

The specimens sent forward by Mr. Palmer were extremely interesting, ar showed distinctly the work of two different insects which attacked the roots in a sir ilar manner, but could be easily distinguished. All the plants sent were old plan with large crowns, from a stout caudex; and it was into this that the larvæ bored fro the outside, leaving large cavities, and in some instances destroying the whole of t interior of the stems. By the time the parcel reached Ottawa, most of the specime were pupæ, and from these a little later I reared several specimens of the Black Vi Weevil and of the SLEEPY WEEVIL *(Otiorhynchus ovatus,* L.). This latter is a cor mon weevil, and is a curious slow moving creature, which is frequently found in ou of-the-way places. It may always be found out of doors at almost all times of t year, when sifting moss or leaves to collect beetles. It frequently penetrates in houses, sometimes in large numbers, and it has even been accused, with every appea ance of good reason, of having inflicted very painful bites on campers sleeping tents during the summer time. It occurs commonly throughout Canada east of t prairies, but I had not heard of it previously from British Columbia. The Slee Weevil has occasionally been accused of injuring potatoes, and Mr. P. J. D. Edmon sent me from Summerville, P.E.I., specimens with potato leaves, and the followi note: 'I send you a sample of a new kind of potato beetle, showing the way he fol himself up after cutting off the branches of potatoes. Please let me know what th is, and whether he is doing damage or how he can be destroyed. I did not actu see this field, but I am told that many of the stalks are stripped bare of leaves.'

The Sleepy Weevil is only about half the size of the Black Vine Weevil, a of a dull pitchy brown colour, smooth and without any markings. It is always a ve slow moving beetle, and it is probable that some injury may have been attributed to for which it was not responsible. From its habit of hiding in dark corners, fold leaves and in hollows, it is frequently found in close proximity to injury which ma have been done by other culprits. There is now no doubt that the larvæ feed on t roots of strawberries, and it is probable that they also attack the roots of many oth plants. I have frequently found the beetles in old grass fields, and I shall not be su prised, especially after the observation made by Mr. Dashwood-Jones that strawber beds planted on sod were most injured by weevils, to find that the usual food plant both the Sleepy Weevil and its larger companion, the Black Vine Weevil, may be t roots of grasses. Should these insects become abundant in strawberry beds it will well for growers to adopt the one-crop plan which has been used very successfully Mr. Macoun, the Horticulturist of the Central Experimental Farm, and was adopt many years ago by Mr. Peter Dempsey, at Trenton, Ont. This consists of settin out new beds of strawberries in the spring, cultivating these for the first summe taking one large crop of berries the next spring, and then ploughing the plants up soon as the crop is off. In the meantime a new bed will have been set out from t runners of the bearing bed early in spring before the fruit ripened. This plan strawberry culture not only prevents loss from the attacks of such enemies as t White Grub and the above-mentioned Weevils, but is also a paying operation, givin better returns from the higher price secured with the large fruit thus grown than fro a large crop of smaller berries.

Both of the weevils here treated of are nocturnal, doing such injury as is attr butable to them at night and remaining quiet by day, hidden away in crevic o beneath rubbish and other shelters. They can, therefore, be trapped in considerab numbers by placing objects about the beds convenient for them to hide in by day, an also easy of examination for the destruction of the beetles.

FOREST AND SHADE TREES.

No widespread or extensive injury to forest or shade trees was brought to my notice during the past season, but there were many inquiries sent in with specimens for information concerning these insects.

TENT CATERPILLARS of several species, which a few years ago were so enormously abundant, but which everywhere suddenly decreased in 1900, seem to be again increasing in certain districts, not only on forest trees, but also in orchards. There is some confusion as to the species mentioned in reports; but western references are probably to *Malacosoma (Clisiocampa) californica*, Pack., and *M. americana*, Fab., northwestern to *M. disstria*, Hbn., and *M. fragilis*, Stretch, and eastern to the Apple Tree Tent Caterpillar, *M. americana*, and the Forest Tent Caterpillar, *M. disstria*.

Mr. J. R. Anderson says:—

Victoria, B.C., Nov. 1.—The Tent Caterpillars again appeared in larger numbers than usual this year. In some localities on the lower Fraser and in those places where no steps were taken to check their ravages, fruit and ornamental trees were utterly defoliated, and this was also the case with trees and bushes on the roadside.'

When travelling in northern Alberta last summer, holding meetings with Mr. T. N. Willing, the Territorial Weed Inspector and Entomologist, I found, on July 21, two destructive colonies of what I took to be the Forest Tent Caterpillar *(M. disstria)*. The first one was in a bush of many acres of Aspen Poplars, a few miles out of St. Albert. The moths were in thousands and were just emerging from the cocoons. Only a few dipterous and hymenopterous parasites were noticed at large or detected by their larvæ in the cocoons. The second colony was close to the town of St. Albert and was less extensive than the first one referred to, the chief injury being done on the tops of young aspen trees. Earlier in the season Mr. Willing sent me specimens of the larvæ of *Malacosoma fragilis*, Stretch, which he had found abundant on rose and other bushes at Medicine Hat. There are a few reports of injury by Tent Caterpillars in orchards and wood lots in western Ontario; and I hear from Nova Scotia that Tent Caterpillars are evidently again increasing in numbers.

The remedy for all these species, where practicable, is prompt spraying as soon as the young caterpillars appear, with poisonous mixtures.

BASSWOOD LOOPER [*Erannis (Hibernia) tiliaria*, Harris].—Mr. T. N. Willing found caterpillars of this eastern moth very abundant on the flat north of the south branch of the Saskatchewan at Medicine Hat. They were stripping the Negundos or Ash-leaved Maples (also called Box-elders in the United States), and skeletonizing all the leaves on some trees over an area of more than two acres. A moth was reared from these caterpillars, which like the larvæ, did not appear to differ in any way from eastern specimens.

The NEGUNDO TWIG-BORER (*Proteopteryx willingana*, Kearf.).—For many years the Ash-leaved Maples grown at Winnipeg, Brandon, Regina and other points in the West as street shade trees, have been injured every season by the caterpillars of a small moth, which burrow in the bases of small twigs and branches, and hollowing these out, cause them to swell and form elongated galls. These have occasionally been reared, and some years ago moths were sent to a specialist who identified them as *Proteoteras æsculanum*, Riley. Under this name the insect has been referred to until the present season, when several specimens were reared by Mr. T. N. Willing, of Regina, and were forwarded to Mr. W. D. Kearfott, a specialist in microlepidoptera.

(See 'Canadian Entomologist,' vol. xxxvi., 1904, p. 306.) After careful examination they were decided to be an undescribed species, which was named in honour of Mr. Willing, as a recognition of the excellent work he is doing in working up the natural history of the North-west Territories. The caterpillars attain full growth during June and then leave their burrows in the twigs, and penetrating a short distance into the ground, spin close cocoons from which the moths emerge early in July. Some caterpillars of this moth, however, reared here in the Division of Entomology, pupated in the twigs where they had been feeding. It cannot be said that this insect does very serious injury to the Negundos; but it is sometimes extremely abundant and by destroying shoots makes it difficult to train these favourite trees in the way desired by those growing them as shade trees.

The NEGUNDO PLANT-LOUSE *(Chaitophorus negundinis,* Thos.).—As might be expected from the enormously extended area over which the Ash-leaved Maple or Box-elder is cultivated of late years, the insects which attack it are gradually spreading from the west with their host plant. One of the most troublesome of these is the Negundo Plant-louse, which for many years has been a disgusting pest of shade trees in the West, covering the trees with honey-dew during the summer and making them very unsightly objects instead of ornaments, in the streets, by reason of the copious growth of the Sooty Fungus (*Fumago salicina*), which always develops as a consequence of their attack. From several points in Ontario during the past summer, even as far east as Ottawa, this plant-louse was reported upon the Ash-leaved Maple trees. When not controlled by spraying with kerosene emulsion or whale-oil soap solution, these plant-lice do serious injury to the trees they infest; and they are so persistent in their attacks that many lovers of trees in the West have given up the cultivation of th[e] desirable and quick-growing Negundo, for other trees less subject to insect attack.

The ASPEN BEETLE *(Lina tremulæ,* Fab.).—Mr. Norman Criddle, of Aweme, Man., writes : 'These beetles, which three or four years ago were so enormously abundant and did so much harm by stripping the aspen poplars, are once more on the increase. They were especially destructive to the young shoots of the aspens, causing many young trees to die.'

In 1900 and 1901 this bettle was so abundant and destructive on the prairies that many miles of beautiful aspen poplars so useful in that country for firewood and shade, were stripped bare of foliage, and a great many of the trees died. This was particularly the case in the Tiger Hills, Man., and in the Moose Mountain and Qu'Appelle districts, N.W.T.

WILLOW BEETLES.—For the last three years willows in the prairie provinces and in British Columbia have been very much injured by the small chrysomelid beetle, *Galerucella decora,* Say. This is a small brown beetle, soft, and rather flat in shape, which, both in the perfect and larval states, feeds on various kinds of willows, stripping the green surface of the leaves and leaving the bushes seared and brown. Mr. Criddle says: 'Willows at Aweme were completely stripped by these beetles and their larvæ. Later in the season, aspen poplars (*P. tremuloides*) were also attacked by the same beetles to such an extent that any one knocking a tree would shake down countless numbers from the leaves, which sounded, as they fell on the dead leaves beneath, like a shower of rain. These insects pass the winter beneath the dead leaves, and attack the trees as soon as they come into leaf the following spring. Many trees were killed by them some years ago.'

The VANCOUVER ISLAND OAK-LOOPER [*Therina (Ellopia) somniaria,* Huslt].—As stated in my report for 1890, the beautiful oaks on Vancouver Island are periodically stripped, every few years, by hordes of the caterpillars of a geometrid moth. 1904 saw one of these visitations. Mr. J. R. Anderson writes: 'The Oak Looper (*Ellopia somni-*

aria) appeared in vast numbers in some places on Vancouver Island this year. Strange to say, in certain localities they were entirely absent, but in others they were so numerous that they consumed every particle of their natural food, and they would then attack other trees. In one place, which I was called to inspect, I found that they had attacked even the fruit on apple trees, eating away a layer of the skin and large holes into the interior near the stem. They were also denuding the apple trees of their leaves. There were hundreds on one tree which stood beneath an oak. The larvæ had defoliated the oak tree, then let themselves down in the usual manner, and were on the apple tree in hundreds eating the foliage and fruit. Other trees, as cherry, elm, &c., farther away were also attacked, but not so much as those near the oaks.'

This variation in the food habits of this insect can, I think, only be considered as exceptional. The natural food of the species in Vancouver Island is the picturesque oak, *Quercus jacobi*, R. Br., which grows round the southern end of Vancouver Island. Among the caterpillars forwarded by Mr. Anderson, some parasitized specimens were found, from which was raised a parasite which has been kindly identified by Mr. W. H. Harrington, as *Pimpla Ontario*, Cress. Another parasite, the species usually responsible for the sudden reduction in the numbers of this species, is *Ichneumon cestus*, Cr., a yellowish brown ichneumon fly about three-eighths of an inch long, with one black band across the abdomen, and was found in considerable numbers by Mr. A. W. Hanham, who writes:—

'Victoria, B.C., October 25.—The moths of the Oak Looper (*E. somniaria*) have this autumn been a sight to see. Out the Cadboro Bay road large oak trees were covered with the moths a couple of weeks ago, particularly on the underside of the branches and close to the trunks. There were numbers of a reddish brown ichneumon, all of one species, which were flying about the trunks of the trees. I bottled several of these, which I send you.'

The specimens forwarded by Mr. Hanham were *Ichneumon cestus*, Cr.

The WHITE-MARKED TUSSOCK MOTH [*Hemerocampa (Orgyia) leucostigma*, S. & A.] —This common pest of city shade trees, which was referred to at some length in my last report, continues to injure shade trees in some of our cities. The most effective remedies are the collection of the egg masses in winter and the spraying of the trees with arsenical poisons in spring before the caterpillars (Plate II., fig. 9) have grown much and injured the leaves. The Toronto civic authorities are this year taking active measures to clear out the infestation, which for many years has injured the appearance of the beautiful horse chestnut trees for which Toronto is celebrated. A reasonably large sum of money has been voted for the collection and destruction of the eggs during the present winter; and there is every reason to hope that by this means private individuals may be stirred up to do their duty in the public interest by destroying the eggs on their own trees in winter and then spraying the foliage in summer for a year or two.

WALKING STICK INSECT (*Diapheromera femorata*, Say).—A remarkable outbreak of the Walking Stick Insect, which is worthy of record, is reported by Mr. J. B. Williams, of Toronto. This is usually a rather uncommon insect; but Mr. Williams found it in such numbers in the Niagara Glen that thousands might have been collected on oak and butternut trees during September. These trees are ordinary food plants for this curious insect, which belongs to the Phasmidæ, a division of the Orthoptera, the same order as contains the locusts and grasshoppers.

THE APIARY.

The Apiary, as in the past, has been under the management of Mr. John Fixter, the farm foreman, whose report I append herewith. The same experiments which have been carried on for some years have most of them been repeated on account of the large amount of interest which has been evinced in the subject by correspondents and visitors to the Central Experimental Farm. The services of Mr. Fixter have been asked for at a great many meetings of bee-keepers, and, whenever his duties at the Central Experimental Farm would permit of it, he has attended these meetings and given addresses.

REPORT OF MR. JOHN FIXTER.

Season of 1904.

The honey crop in the Experimental Farm Apiary has been a fairly good one, giving an average yield of 63 pounds per colony.

In many parts of the Dominion the honey crop was light, owing chiefly to the very heavy losses of the past winter. Many colonies of bees perished from cold, while they had abundance of stores in their hives. The continued long spells of severe weather prevented them from breaking their clusters to reach their stores. Losses were greater in outside than in inside wintering, although many perished inside, either from insufficiency of stores or from confinement in cool, damp and badly ventilated cellars.

Experiments have shown that bees can be successfully wintered in a good cellar even if it is damp, providing it is well ventilated. Many colonies died also during the spring after being set out, owing to the cold, backward season.

The number of colonies, which was 35 in the spring, was increased by swarming to a total of 50 when the hives were put into winter quarters on November 23.

Meetings were attended at the following places in Ontario :—Merivale, Metcalfe, Crossland, Phelpston, Minesing, Grenfell, New Lowell, Stayner, Elpin, McDonald's Corners, Balderson, Innisville, Drummond Centre, Locust Hill, Markham, Gananoque, Toronto and Barrie; and in the province of Quebec at Shawville, Buckingham and Venosta.

Experiments, 1903-1904.

I. CELLAR WINTERING.

Description of the Bee Cellar.—The cellar is below a private house. The walls are of stone and the floor of cement. The bee-room, 11 feet 6 inches wide by 15 feet long and 7 feet high, allows three tiers of shelves and two passages. It is boarded off from the remainder of the cellar by a partition which extends all around the chamber, and far enough from the stone wall to allow of an air space. Should a person have enough bees to fill the cellar the boarding could be left out. Under the cement floor a layer of one foot of stones of different sizes acts as a drain and keeps the cellar perfectly dry. The lowest shelf is 18 inches from the floor, the second 20 inches in the clear above, and the third 20 inches above that. Neither the hives on the third or uppermost shelf nor the uprights supporting the shelves touch the ceiling, so that no vibration can reach the hives from above. This chamber is thoroughly ventilated, as is also the whole cellar.

Before entering the bee room is a smaller compartment with a door leading to the outside and another leading to the bee-room. Both rooms have sliding ventilators in the doors, so that outside air may be let in at will. Ventilation is carefully attended to, and sudden changes of temperature are avoided; for this, a thermometer which is

always kept in the cellar, is watched. The best temperature for the bee cellar has been found to be from 42 to 48 degrees Fahrenheit. This arrangement has given entire satisfaction. In former years there was not proper ventilation, and the cellar was always damp. Since the concrete floor has been laid and the ventilators have been put in, the cellar has been much drier and cleaner. It is also rat and mouse proof, which is a very great advantage.

Experiment No. 1.—The tops of the hives replaced by chaff cushions and the brood chambers raised at the back.

Six colonies were put into winter quarters in the cellar and placed on the shelves. Under the back end of each hive was placed a three-inch block; each hive was, besides, raised from its bottom board by a one-inch block being placed at the back so as to ensure free ventilation. All front entrances were left wide open; the wooden covers were all removed and replaced with cushions made of chaff 4 inches thick, sufficiently wide and long to lap over the hive two inches. Temperatures were taken once each week all through the winter and were kept very even, from 44 to 48 degrees. The bees were quiet, only a very slight hum being noticeable up to February, when the temperature having risen to 48, the bees began to get uneasy and made considerable hum. Cold air was carefully let in during the night by opening the slides in the doors and closing them in the morning; this, of course, lowered the temperature, and the bees quieted down. During the past winter every colony in this experiment was perfectly dry and clean, and all came out in excellent condition. Average weight of each hive when put into winter quarters, 58½ pounds; when taken out on April 22, 49¼ pounds per hive, showing that each hive had lost 9¼ pounds on an average.

Experiment No. 2.—Tops replaced by chaff cushions and the brood chambers raised in front.

Six colonies were put into the cellar and placed on the shelves, a three-inch block being placed only in front, between the bottom board and the brood-chamber, making the full entrance three inches high across the whole front. The wooden covers were removed and replaced with a chaff cushion. Temperature the same as in Experiment No. 1. During the whole winter all the colonies in this experiment were perfectly dry and clean and showed no uneasiness of any kind. The bees could be seen hanging in a quiet cluster below the frames any time during the winter. The average weight when put into winter quarters on November 23 was 59 pounds 12 oz.; when taken out on April 22, 51 pounds 8 oz., showing that each hive had lost on an average 8 pounds 4 ounces.

Experiment No. 3.—Tops replaced by propolis quilts.

Six colonies were put into the cellar and placed on the shelves, with the bottoms of the hives left on, just as they were brought in from the bee-yard. The wooden covers were removed and nothing left on except a tightly sealed propolis quilt; the natural entrance was left wide open. Temperature of cellar same as in Experiment No. 1. During the entire winter the bees kept perfectly dry, and only a very slight hum could be heard. There were but very few dead bees on the bottom board, and no sign of dysentery. On examination when set on their summer stands all the hives were found to be in first-class condition. The average weight when put into winter quarters November 23 was 59 pounds 15 oz.; when taken out on April 22, 51 pounds 3 oz., showing that on an average each had lost 8 pounds 12 oz.

Experiment No. 4.—Tops and bottoms of hives left on.

Six colonies were put into the cellar and placed on the shelves, with tops and bottom boards of the hives left on, just as they were brought in from the bee-yard.

They were watched for dampness, mould, or dysentery, also to compare the amount of honey consumed. Temperature of cellar the same as in Experiment No. 1. During December and January all were very quiet. During February there was considerable humming. Drops of water were noticed along the entrances of three hives. There were but very few dead bees on the bottom board and no sign of dysentery. On examination when set on their summer stands, two of the hives had considerable moulded combs. The average weight when put into winter quarters, 58 pounds 10 oz.; when taken out on April 22, 49 pounds 3 oz., showing that the average loss of each hive was 9 pounds 7 oz.

II.—WINTERING BEES IN DAMP CELLARS.

Many letters are received inquiring whether a damp cellar is a fit place to winter bees in. An experiment was conducted during the winter of 1902-3, with three colonies of bees. During last winter it was thought advisable to try the same experiment (A) with a larger number of colonies—six—and another (B), also with six colonies with a larger amount of moisture.

In both experiments the six colonies were selected, all of about equal strength, and all in Langstroth hives, weighing on an average 58 pounds each at the beginning of the experiment. The wooden covers were removed from the hives and replaced with propolis quilts ; the bottom of each hive was loosened from the brood chamber, and a block two inches square was placed at each corner between the bottom board and the brood chamber, insuring free ventilation from the bottom of each hive. The cellar was kept at a very even temperature of 44 to 48 degrees, and was well ventilated during the whole winter. The six hives in each experiment were resting on the edges of seven pails of water, the full surface of the water being exposed.

A.—The bees could be seen hanging below the frames in a quiet cluster all winter. The hives were all examined once each week, and at no time did there appear to be any sign of uneasiness from the extra moisture. There were scarcely any dead bees on any of the bottom boards nor any sign of dysentery, and all came out in excellent condition. The colonies were set out on their summer stands on March 20; the day being fine and warm, all began to fly at once. The average weight of the six colonies when set on their summer stands was 44¼ pounds each. From March 20 to April 5, the weather was cool, and no flying took place up to the latter date, which was a good bright warm day. After this the bees had to remain in their hives until April 22, when the weather became warm again. They then built up rapidly and were in excellent condition for the honey flow.

B.—A second experiment was tried in which the amount of moisture in the atmosphere of the cellar was increased in the following way: Besides the seven pails of water placed on the floor with the six hives resting on the edges of these pails, allowing the full surface of the water to be exposed, six inches of sand was spread on the cellar floor between the pails and covering six inches of the floor outside of the pails. There was also a large cotton sheet spread over the six hives. The sand and sheet were kept thoroughly saturated with water which was poured on them once each week during the winter.

The bees in this test were more uneasy than in the experiment first described where no sand or cotton covering was used, having to keep up fanning for ventilation. There were also a great many more dead bees on the bottom boards and several hives had drops of water along the entrance, but there was no sign of dysentery. On March 20, the day being fine, the colonies were removed to the bee-yard, where all began flying at once. The average weight of the six colonies when set on their summer stands, was 44¼ pounds each. From March 20 to April 22 the bees had but one good flight. After April 22 the weather became considerably warmer; the colonies began building up rapidly, and were in excellent condition for the clover bloom.

The average strength of the six colonies that had the extra moisture was not as great as in the former test, but as soon as they got fine weather they gained rapidly.

Care was taken that the colonies in both tests had plenty of unsealed stores before fruit bloom and between fruit and clover bloom. This was done by uncapping one side of a frame of honey nearest to the cluster, allowing the bees to use up the honey for food and providing space for the queen to lay her eggs. Although so much moisture was in close proximity to the colonies, a great deal of the success of this experiment is no doubt due to the good cellar in which it was tried, the cellar having stone walls, cement floors, good ventilation and the temperature being easily regulated. This goes to show that good ventilation and even temperature have a great deal to do with successful wintering. An excellent plan for ventilating is to have sliding ventilators in the doors, so that much or little air may be let in as desired. Also connect an extra stove pipe, provided with a damper, to the regular heating stove. This may be done by means of a T, or an extra flue will answer. Allow the pipe to extend into the cellar. This plan of ventilating has proved very successful.

III.—INSULATING HIVES FOR OUTSIDE WINTERING.

For this experiment, the hives were insulated against the winter cold by air cushions in the following manner. Slats 1 inch thick were nailed at intervals all around the hive, on these was tacked one layer of thick brown building paper and then a layer of oiled paper, which increases durability and also keeps out vermin. In order to provide extra protection to the hive, a box six inches wider and six inches longer was placed over this with an opening cut at the entrance, 1 inch by 2 inches, all other openings being closed. The wooden covers of each hive were removed and replaced with a chaff cushion 3 inches thick, the latter placed on the propolis quilt, and lapping over the sides of the hive; two layers of paper were then put on top of the cushion and a second cushion added, which had the top of the outside box over it. This experiment, first tried during the winter of 1902-3 with two hives, was repeated last winter for the second time with four colonies in Langstroth hives. These were all four placed in a large packing case, one foot larger each way than the hives, which were six inches apart in the case, with six inches of cut straw on the bottom of the case for the hives to rest upon. The six-inch space between the hives was packed with cut straw, as well as the one-foot space all around and on top of the hives. The entrances of two of the hives faced each other, and two hives faced west. The entrance to the hives was kept clear of snow all winter to ensure free ventilation. The hives were in a corner well sheltered from cold winds.

No sound could be heard from these colonies all winter. On March 22 the bees made their appearance, many flying briskly, going out and returning. From March 22 to April 22 the bees had but one good flight. On April 22 they were then examined. Very few dead bees were found on the bottom boards; the combs were dry and clean and there were no signs of dysentery. The hives were then removed from the packing case and placed on their summer stands. The average weight of the hives when put into winter quarters was 62½ pounds; when put on their summer stands, 49¼ pounds, showing that each hive had lost 13 pounds 4 ounces. The weather after this date (April 22) being bright and warm, the bees built up rapidly and were in excellent condition for the honey flow.

IV.—EXPERIMENTS TO DETERMINE WHICH BEES WOULD CONSUME MOST OF, HONEY OR SUGAR, WHILE CONFINED IN THEIR WINTER QUARTERS.

Eight colonies in Langstroth hives were selected for this experiment, all of as nearly equal strength as could be secured. On September 1 their natural stores were removed from both sets. On September 2 all were weighed as follows:—

(*a.*) The four colonies fed sugar syrup: No. 1 weighed 30 lbs. 7 oz.; No. 2, 31 lbs. 12 oz.; No. 3, 31 lbs. 10 oz.; No. 4, 31 lbs. 3 oz.; average of weight, 31 lbs. 4 oz.

(*b.*) The four colonies fed extracted honey: No. 1, weight, 30 lbs. 9 oz.; No. 2, 31 lbs. 10 oz.; No. 3, 30 lbs. 12 oz.; No. 4, 31 lbs. 1 oz.; or an average of 31 pounds.

Miller feeders were placed in empty section supers, close to the top of the brood frames, any part of the brood frames not covered by the feeder being covered by a propolis quilt cut so as to allow the bees a passage through it. By keeping the feeder well packed around, except where the bees enter, the heat is kept in and at the same time the bees cannot daub themselves with the liquid. In both experiments the bees had a constant supply of syrup and honey. Both the honey and the syrup were supplied to the bees at about blood heat. The syrup was made of the best granulated sugar, two parts to one of water by weight. The water was first brought to a boil then the boiler was set back on the stove and the sugar having been poured in, the mixture was stirred until all was dissolved.

The four colonies fed sugar syrup when put into winter quarters November 24 weighed as follows:—

No. 1, 61 lbs. 4 oz.; No. 2, 62 lbs. 9 oz.; No. 3, 62 lbs. 7 oz.; No. 4, 62 lbs.; or an average of 62 lbs. 1 oz. each.

The four colonies fed extracted honey when put into winter quarters on November 24, weighed as follows:—

No. 1, 62 lbs. 13 oz.; No. 2, 62 lbs. 14 oz.; No. 3, 62 lbs.; No. 4, 62 lbs. 5 oz.; or an average of 62 lbs. 8 oz. each.

The four colonies fed sugar syrup when taken from their winter quarters March 22, weighed as follows:—

No. 1, 47 lbs, 3 oz.; No. 2, 49 lbs. 4 oz.; No. 3, 51 lbs. 5 oz.; No. 4, 51 lbs. 8 oz; average, 49 lbs. 13 oz.

The four colonies fed extracted honey when taken from their winter quart[illegible] March 22, weighed as follows:—

No. 1, 50 lbs. 9 oz.; No. 2, 53 lbs. 1 oz.; No. 3, 51 lbs. 12 oz.; No .4, 51 lbs. 2 oz.; average, 51 lbs. 10 oz. Difference in favour of the honey feeding, 1 lb. 13 ounces per colony.

When the hives were put into winter quarters and placed on the shelves in the cellar, the wooden covers were raised at one end ½ an inch, while the sealed propolis quilt was left undisturbed. The hives were all given extra ventilation at the bottom by placing at the entrance a wooden block between the bottom board and the brood chamber, thus raising the front of the brood chamber 3 inches extra. During the balance of November and December very slight humming could be heard; during January and February scarcely any appreciable hum could be heard. During the whole winter there was no sign of uneasiness of any kind, and very few dead bees were found about the entrance; the bottom boards were quite clean and there was no sign of dysentery in either experiment. All came out in first-class condition and built up rapidly for the honey flow.

V.—EXPERIMENT WITH QUEEN EXCLUDERS IN HIVES FOR THE PRODUCTION OF EXTRACTED HONEY.

Eight colonies were taken for this test—4 in Langstroth hives, 4 in Heddon hives.

Two colonies in each case had queen excluders between the brood chamber and the extracting frames; thus, every pound of honey secured was pure.

The two remaining colonies in each set had no queen excluders. The queen [illegible] every instance went up into the extracting frames where eggs were laid [illegible] young brood raised. This latter plan is practised by too many who call the[illegible] selves bee-keepers. It is impossible to extract honey from frames where brood is present without throwing out the young larvæ at the same time. There are also many who do not use any surplus cases, especially those who use the old box hive. They take their honey out of the brood chamber after smoking or killing the bees. This

practice is to be strongly condemned, as the honey taken out of a brood chamber, or out of extracting frames where brood is present is not fit for human food.

On November 8, all colonies were weighed and found to be in good condition. They were then put into their winter quarters.

Introducing Queens.

Eight queens have been introduced during the season, four on the Benton plan and four with frames of brood taken from several hives. All queens belonging to the colonies that were to receive the imported queens, were removed 24 hours before introducing the new queens.

ONE METHOD—'BENTON INTRODUCING CAGE.'

The Benton mailing and introducing cage is ordinarily used in this country. It consists of an oblong block of wood with three holes bored nearly through, one of the end holes being filled with good candy, and the other two being left for the occupancy of the bees and queen. On the back of the cover are printed directions for introducing a new queen into a hive, and at each end of the cage is a small hole bored through the end of the block of wood, but which in the mails is stopped by a cork. One hole is for the admission of the bees and queen preparatory to mailing, and the other for the liberation of the queen, by the bees eating out the candy in the course of 20 to 30 hours, thus releasing her in a natural way. When the cage is received, the cork covering the candy is to be removed, as well as the wooden cover over the wire cloth. The cage is then carefully placed on top of the frames, so that the wire cloth be over the space between two frames in the centre of the brood-nest. The queen will then be released by the bees in the manner explained.

I would advise all to have extra cages for introducing, so that no disease may be brought in with the queen. See that the cage you introduce with is thoroughly cleaned, and have fresh food made from your own honey placed in the cage in readiness. Then remove the queen and bees from the cage they were received in, to the one prepared for them and follow the above directions.

How to Make Honey and Sugar Thick for Feeding.

Take good thick honey and heat (not boil) it until it becomes very thin, and then stir pulverized sugar into it. After stirring in all the sugar the honey will absorb, take the mixture out of the vessel, and thoroughly knead it with the hands. The kneading will make it more pliable and soft, so that it will absorb or take up more sugar. For summer use it should be worked, while mixing in a little more sugar, until the dough is so stiff as to be hard to work; it should then be allowed to stand for a day or two; and, if still so soft as to run, a little more sugar should be kneaded in. A good deal will depend upon the season of the year; there should be more sugar in proportion to the honey in warm weather than in cool weather.

ANOTHER METHOD OF INTRODUCING QUEENS.

Select a strong colony, remove the wooden cover of the hive, and place a fine wire netting over the tops of the brood frames to shut in the bees; place on top of this wire cloth a brood chamber with four frames of well sealed brood, selected from different hives, with young bees just hatching out, but with no unsealed brood. Put the queen in this brood chamber, which should then be closed bee-tight, and kept over the strong colony four or five days. By that time a respectable force of young workers will have hatched; the hive may now be placed on the stand where it is to remain, the entrance being made large enough for only one bee to pass at a time, as a precaution aganist robbing. The entrance may be widened as the colony gets stronger. This latter plan has never failed with me.

JOHN FIXTER.

DIVISION OF BOTANY.

THE RUSTS OF GRAIN CROPS.

The losses from the attacks of different kinds of rusts on the cereal crops of the Dominion during 1904, were considerable, and have been reported from every part of the Dominion. In Manitoba and the North-west Territories rust on grain is very seldom heard of; but during the past autumn just about the time the grain was ripening the climatic conditions were such that rust developed to an alarming extent. The parasites which cause this disease are always present to a certain degree on grain crops as well as on several kinds of the wild prairie grasses, and this year they spread on the grain crops and were the cause in some places of great loss to farmers. There was so much interest created among settlers in the West that I was requested to prepare an article upon the subject for the Montreal *Family Herald and Weekly Star*, which was published in the issue of November 30 last. As it is of general interest and a great many inquiries have been made for a popular description of the disease and its cause, I reproduce the article herewith.

THE RUST OF WHEAT.

The subject of the rusts of grain crops is of special interest just now, owing to the unusual epidemic of these destructive parasites in the large wheat fields of parts of Manitoba and the eastern North-west Territories during the past season.

The loss from this cause was undoubtedly considerable; but there was no such wholesale or widespread destruction of the wheat crop in the prairie provinces, as was described in some United States and English newspapers. I have had opportunities of examining samples of rusted straw from many localities, which have been kindly sent in by Mr. David Horn, Chief Inspector of Grain, at Winnipeg, by the agricultural papers and by several correspondents. As a report on the whole of these samples, it may be said that, although some were seriously affected by rust, not one of them was as badly rusted as crops are frequently found to be in eastern Canada, which are nevertheless thought to be worth cutting for grain.

In passing through the Territories and Manitoba in the second week of August, although the crop was rather late and green, I saw no appearance of rust, nor did I hear any complaints of its occurrence at that time. The first reports were received about the 20th August. Early in September several items in the newspapers showed that there was much anxiety as to the extent of the loss which might occur. The localities where most harm was done, were in the Red River valley, in south-western Manitoba and in eastern Assiniboia. In the Regina district a few crops are said to have been so badly rusted that they were burned. The rust in these fields appears to have been noticed on the leaves and heads about the middle of August. On the 18th of that month there was a hailstorm, accompanied by rain; and immediately afterwards the rust spread rapidly.

In Manitoba, for fear of further injury, some crops of wheat were cut too green to be of use for grain, or were made into hay. Under the circumstances, and, as the season turned out, this was a wise course; for it has been found by Mr. Shutt, the Chemist of the Experimental Farms, that straw attacked by rust makes far better feed for stock even than clean straw, because the presence of the parasite causes the retention in the straw of the nutritious principles which after the seeds are formed are transferred from the straw into the grain.

THE EFFECT UPON THE WHEAT PLANT.

The physiological effect upon the wheat plant by the presence of the rust parasite is better understood by a consideration of the life history of the minute plants which are known as rusts. The term Rust, as applied to cereals, describes a disease due to the attacks of several different parasitic fungi belonging to the Uredineæ, a family which includes the most destructive parasites of cultivated and wild plants; and it must not be forgotten that rust is a plant, and, although so minute that a strong microscope is required to examine it, it is just as much a true plant with a definite life history of its own, as the wheat, oats, grasses, &c., upon which it grows.

The general belief that rust comes with rain, fog, or heavy dew after a hot day, is in the main correct; but the moisture and hot air are not actually the cause of the trouble; they merely act as the carriers of it and provide the conditions necessary for its injurious propagation.

The rust which was answerable for nearly all the injury in the West last season, was the Black Stem Rust. There are about a dozen different kinds of rusts which occur on wheat, oats and barley in this country. The commonest of these are the Orange Leaf Rust (*Puccinia rubigo-vera*) or Spring Rust, and the Black Stem Rust (*Puccinia graminis*), or Summer Rust, which attack all kinds of small grains, and the Crown Rust, or Orange Leaf Rust, of oats *(Puccinia coronata),* which does not occur on wheat or barley. Each of the first two named species has distinct specialized forms which attack wheat, oats and barley and some other grasses, but which very seldom infest plants belonging to other grains than those upon which they developed. For instance, spores of the Black Stem Rust of wheat will not produce readily on either barley or oats the corresponding rusts of those plants and *vice versa.* The two common rusts of wheat occur in all parts of the world, where that staple crop is grown; and in almost every instance it has been found that the Black Stem Rust is by far the more injurious of the two. The Orange Leaf Rust appears earlier in the season and is the more conspicuous; but the later-developed Black Stem Rust attacks its host in a much more vulnerable spot, namely on the stem, the channel up which the nutritious principles are carried from the vegetative system of the plant to be stored up in the seed. Developing on the stem, it arrests and feeds upon these important elements, thus causing starved and shrunken grain. The Orange Leaf Rust of oats is a different species from the Orange Leaf Rusts that occur on the other small grains; and like them has a red rust or spring form and a dark-coloured or summer form; but the Black Stem Rust of oats is merely a specialized form of the species (*Puccinia graminis*), which is also found on wheat, barley and rye, as well as on many different kinds of grasses.

THE GROWTH OF THE PARASITE.

In the case of the Black Stem Rust, the growth of the parasite is the same, whatever its host plant may be. It passes the winter in a resting condition on the old stems of the previous year. In the fields this will be chiefly on the stubble. The winter-spores or seed-bodies germinate early in spring and produce another kind of spores, which are exceedingly light, and are borne from place to place by the faintest breath of wind. These, alighting on the growing grain plants, produce, later, what is known as the red-rust or uredo stage of the fungus, to be followed in autumn by the resting winter-spores of Black Stem Rust. The sequence of this development is as follows: As soon as the minute spores of the first germination are carried on to a leaf of a growing plant, they germinate and throw out very slender tubes, which enter the tissues of the host plant in the same way that roots penetrate the soil. Here they feed at the expense of their host, and in time produce large numbers of reddish brown spores, which burst through the tissues and cause the red-rust stage, which again, later on in the season, is followed by the black-rust stage, which consists of the pro-

fuse production of another kind of spores, brownish black in colour. These are the teleutospores, and are the means of carrying the parasite over the winter. These black winter-spores frequently appear in this species in the same spots on the stem, where the red-rust stage was earlier in the season, but do not germinate until the following spring.

RUST AND THE BARBERRY.

In addition to these two forms of the Black Stem Rust, there is another stage which has been the subject of much controversy. This comes from the spores of the first generation in spring falling upon the leaves of some species of barberry, where they give rise to a curious fungus, known as Barberry Cluster-cup. After a time this matures and pours out enormous numbers of spores which are carried in all directions by the air and fall upon grain plants, where they give rise to Red Rust. Strange to say, this remarkable fact in the life history of rust was discovered very many years ago, and laws looking to the extermination of the barberry plant date back to 1660, when an Act having this object in view was passed in France.

It is not, however, absolutely necessary for Rust to have its first stage on the barberry, although experiments have shown beyond doubt that it does sometimes occur on that plant. The theory has been advanced that growing in this way in one of its stages on the barberry gives the parasite greater vigour; but it is beyond question that the Black Stem Rust can continue to grow in localities where no barberries are grown, and it is also known to occur in specialized forms on many of the wild prairie grasses. Among the samples of grasses sent to me from Manitoba with the rusted wheat, were specimens of the Skunk-tail grass, or Squirrel-tail (*Hordeum jubatum*), which bore well developed pustules of Black Stem Rust, similar to those which occur on wheat and cultivated barley. The Skunk-tail grass is a very bad weed of the West, and certainly increases in hay lands, owing to a habit farmers have of leaving this grass uncut when mowing, so that it ripens and distributes its seeds. If it were cut down at the same time as hay, the unripe seeds would soon dry up, or might be easily burnt after the hay was carried. Mr. Mark A. Carleton, Cerealist of the United States Bureau of Plant Industry, who has made extensive investigations of rusts, writes as follows:—

'It is positive now from experiments made by this department that the Rust of *Hordeum jubatum* will easily transfer to wheat and barley, and therefore it would decrease the chance of infection of a wheat field, if this grass could be kept out of the wheat, or if the wheat were sown away from its influence.'

REMEDIES.

Little can be done as a remedy against rusts; but, as the parasite passes the winter on the old straw, land left for seeding on stubble should be burnt over carefully before seeding, and the ploughing down of stubbles for summer-fallow should be done as early as possible in the season, so as to prevent as much as may be the distribution of the first generation of spores. Rusted straw fed to cattle is said to distribute the fungus in grain crops from the spores being carried through with the manure. Fresh manure, therefore, should not be used in fields where grain is to be grown. The investigations which have been carried on in Australia, have run largely towards the discovery of varieties of grain which may be more or less exempt from the attacks of rust. Although probably no variety has yet been found entirely free from these parasites, still much has been learned as to the comparative immunity of some kinds, and Mr. Carleton points out that the investigations are said incidentally to have resulted in Australia now having varieties of wheat which are vigorous, true to name, and of exceptional quality for the particular region in which they are grown.

Ever since the institution of the Experimental Farms, much attention has been paid in our experiments with cereals to the problem of rust-resistance. Seed grain has been obtained from all parts of the world. The Australian and many other varieties said to be of special quality have been secured and experimented with, with a view to ascertaining the rust-resisting power of each. A vast amount of useful information will be found by looking through the annual reports of the Experimental Farms, where in the tables of yields of varieties, a special column is devoted each year to the amount of injury by rust on every variety of wheat and oats grown at the different Branch Farms. The result of these experiments, as stated above, is that no variety of wheat or oats, so far, has been found which is perfectly free from rust, although by constant selection those varieties are being separated, which have the greatest power to resist the attack of the parasites.

It may be mentioned here that up to the present time experiments in spraying grain fields with Bordeaux mixture and other fungicides for the prevention of rust have not been attended with any success.

ENCOURAGING FEATURES.

There are some features of the rust epidemic of 1904 which may well be borne in mind by western farmers.

1. The extent of injury this year was much influenced by the unusual season, owing to which all crops were later than usual. The spring was late, cool and dry, followed by hot weather, which suddenly changed at harvest time to dull, wet weather of long duration. The result of these conditions was that, at the time when wheat and oats should have been ready to cut, which was the exact time when the rust appeared this year, not only were grain crops in an exceptionally late and succulent state, but the atmospheric conditions, which were very unusual for the region, were just such as would allow of the rapid development of parasitic fungi.

2. Such an extensive outbreak of rust is without any precedent in the history of the Canadian West.

3. As in ordinary seasons rust has been almost unknown in the West, such extensive injury as was experienced in 1904, must be considered as exceptional and not likely to occur again for many years.

J. FLETCHER.

PERMANENT PASTURES.

The following table gives the yields from the permanent pasture experimental plots for the past four years:—

Number.	Seed sown per Acre. Mixtures Nos. 1–17, sown May 4, 1901. Sainfoin, No. 18, sown May 1, 1903.				Cured Hay, per Acre.									
					1904.				Total.					
	Grasses.		Clovers.		June 24.		August 12.		1904.		1903.		1902.	
		Lbs.		Lbs.	Tons.	Lbs.	Tons.	Lbs.	Tons.	Lbs.	Tons.	Lbs.	Tons.	Lbs.
1	Timothy Meadow Fescue Orchard Grass Kentucky Blue Red Top	6 4 2 1 1	Alfalfa Alsike Mammoth Red Common Red White Dutch	2 2 1 1 2	3	880	2	3	5	883	4	520	4	40
2	Meadow Fescue Timothy Canadian Blue Orchard Grass Red Top	6 3 2 3 3	Alfalfa Alsike White Dutch	4 1 1	3	960	2	101	5	1,061	3	1,560	4	660
3	Timothy Awnless Brome Orchard Grass	5 4 2	Alfalfa Alsike	6 3	3	1,021	1	1,320	5	341	4	770	5	120
4	Meadow Fescue Orchard Grass Kentucky Blue	6 2 1	Common Red Alfalfa White Dutch	4 3 1	3	1,079	1	1,381	5	460	4	320	5	1,520
5	Timothy Upright Brome	6 4	Alfalfa Mammoth Red	6 4	3	1,282	1	1,339	5	621	4	840	4	960
6	Timothy	10	Common Red	6	3	880	1	840	4	1,720	2	880	4	760
7	Timothy	10	Mammoth Red	6	3	120	1	520	4	640	1	1,520	3	1,200
8	Orchard Grass	18	Alsike	5	1	1,680		1,892	2	1,572	2	80	2	1,200
9	Orchard Grass	18	Common Red	8	2	360	1	160	3	520	2	1,600	3	1,280
10	Meadow Fescue	20	Common Red	8	2	240		1,997	3	237	2	680	3	40
11	Timothy	12	Mammoth Red	8	2	1,980		1,942	3	1,922	2	1,400	3	1,760
12	Timothy	12	Common Red	8	3	320	1	70	4	390	2	1,920	3	20
13	Timothy Awnless Brome	5 10	Common Red Mammoth Red	5 5	2	1,840	1	1,240	3	1,080	2	1,840	4	300
14	Awnless Brome	25	....		1	1,881		840	2	721	1	1,360	3	1,020
15	Awnless Brome	15	Common Red	8	2	1,889	1	320	4	209	3	360	4	760
16	Timothy	8	Mammoth Red	8	3	1,652	1	129	4	1,781	3	1,160	3	340
17	....		Sainfoin	40	3	1,998	2	1,400	6	1,398	4	1,160	3	1,160
18	....		Alfalfa	15	2	840	1	837	3	1,677				

AUTHOR'S EDITION
FROM ANNUAL REPORT ON EXPERIMENTAL FARMS FOR THE YEAR 1907-8

CANADA

DEPARTMENT OF AGRICULTURE

CENTRAL EXPERIMENTAL FARM

REPORT OF THE ENTOMOLOGIST AND BOTANIST

JAMES FLETCHER, LL.D., F.R.S.C., F.L.S., F.E.S.A.

FOR THE

YEAR ENDING MARCH 31

1908

OTTAWA
GOVERNMENT PRINTING BUREAU
1909

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INDEX.

REPORT

OF THE

ENTOMOLOGIST AND BOTANIST.

(James Fletcher, LL.D., F.L.S., F.R.S.C., F.E.S.A.)

1907-1908

Ottawa, April 1, 1908.

Dr. Wm. Saunders, C.M.G.,
Director of Dominion Experimental Farms,
Ottawa.

Sir,—I have the honour to hand you herewith a report on some of the more important work done in the Division of Entomology and Botany during the year ending March 31, 1908.

The applications for help in fighting insects and weeds from all parts of the country increase in number every year, and many farmers and others visit the Division for advice, or to examine the cabinets to identify plants or insects which are giving them trouble. The demand for help from school teachers and students has increased enormously during the past year or two, since nature study has been recognized as a useful part in a common sense education. Many addresses have been given by the officials of the department on various occasions to help along this movement.

Collections.—The collections in the Division have been much increased during the past year. A large number of specimens have been added to the Herbarium, and the whole has been arranged according to Prof. John Macoun's Catalogue of Canadian Plants, and a card index of the specimens has been completed. In the collections of insects satisfactory progress has been made. The large and valuable collection of noctuid moths has been rearranged, and a large number of specimens which, were lacking, have been procured either by collecting or rearing them, or from correspondents. This class of insects contains the various species of cutworms, some of which every year are the cause of such serious depredations on farm crops. It is always a great surprise to those who find the unsightly cutworms attacking their young plants, when they are shown the moths which come from these caterpillars, many of which are of considerable beauty, notwithstanding the general character of inconspicuous colouring which prevails among the Noctuidæ. Several gaps in our cabinets have been filled in with specimens reared from eggs sent to the Division by correspondents in all parts of the Dominion. Many of these insects are of extreme rarity, and, by getting eggs and then rearing the insect through all its stages, not only are more perfect specimens secured, but, what is far more valuable, a knowledge is acquired of the complete life history of each species, and as it is usually an easy matter to rear insects from the egg, large series showing the range of variation in colour, markings and size are thus secured. The value of the life history of an insect, how it passes the winter, when the eggs hatch and how long a time elapses before the larva becomes full grown and produces the mature form, are facts of enormous importance in devising a remedy

for any species which may have proved destructive to crops. Many insects, particularly moths, lay eggs freely in confinement if enclosed in any small box such as a small cardboard, wooden or tin box, three or four times the size of the specimen. These eggs should be sent off to the Division at once, as most of them hatch in eight or ten days; parcels thus sent have been safely received from the extreme limits of the Dominion, from British Columbia, from Nova Scotia and the far north. The caterpillars, on hatching, are cared for in Ottawa, and the large number of perfect specimens in our collections show to what advantage this method of obtaining specimens and useful information on life-histories may be used. It may be well to mention here to all who are good enough to send in specimens, that full directions as to packing and forwarding such material as plants and insects are given at page 212 in this report.

Among the more important donations which have been made to the entomological collections during the past year, the following may be mentioned:—

Thos. Baird, High River, Alta.—A large number of specimens of rare moths from western Alberta.

J. W. Cockle, Kaslo, B.C.—Several interesting insects from the Kootenays.

The Messrs. Criddle Brothers, Aweme, Man.—Many species of local insects from central Manitoba.

Paul Hahn, Toronto.—Specimens of insects from Niagara Glen and Toronto, including a specimen of *Apantesis virgo* L. var. *citrinaria* N. & D.

Horace Dawson, Hymers, Ont.—Larvæ and moths of the genus *Papaipema,* also supposed larvæ of *Platypsylla castoris* Ritzema.

Edward Denny, Montreal.—A fine pair of the rare moth *Hepialus thule* Strk.

Dr. C. A. Hamilton, Mahone Bay, N.S.—Several interesting species of injurious insects.

A. W. Hanham, Duncans, B.C.—A large collection of British Columbian hymenoptera, diptera and lepidoptera.

W. Metcalfe, Ottawa.—Several boxes of mounted micro-diptera and a few other insects.

Joseph Perrin, Halifax, N.S.—Moths and butterflies from MacNab's Island.

John Russell, Digby, N.S.—Several rare species of Nova Scotian moths and butterflies, including a fine specimen of *Catocala cœlebs,* Grt.

N. B. Sanson, Banff, Alta.—Specimens of Rocky Mountain larvæ, including *Neoarctia beanii,* Neum.

J. B. Wallis, Winnipeg, Man.—Several specimens from Peachland, B.C., chiefly lepidoptera and coleoptera.

C. H. Young, Ottawa.—Eggs of rare Ottawa moths and mounted specimens of lepidoptera and coleoptera which were required to complete series in our cabinets, all beautifully mounted.

A large number of additions have also been made to the collections from material sent in for names by entomologists, farmers and others.

The botanical collections have been enriched from the following sources:—

J. R. Anderson, Victoria, B.C.—British Columbian plants.

A. Arsenault, Adamsville, N.B.—A monstrous form of *Leontodon autumnalis,* L.

The Messrs. Norman and Evelyn Criddle, Aweme, Man.—Seeds, living roots and herbarium specimens of Manitoba plants.

Norman Criddle, Aweme, Man.—A collection of paintings of Manitoba violets.

George Fraser, Ucluelet, B.C.—Rare plants from Northern British Columbia, including living roots of *Viola langsdorfii,* Fisch.

Rev. L. Gladu, St. Boniface, Man.—Botanical specimen of *Œnothera caespitosa,* Nutt.

Dr. W. Grignon, Ste. Adele, Que.—Living roots and stratified seed of Ginseng, *Aralia quinquefolia,* Dec. & Plan.

Dr. C. A. Hamilton, Mahone Bay, N.S.—A collection of 45 named species and varieties of Nova Scotia sea weeds.

David P. Kane, Kaslo, B.C.—British Columbian ferns, including a magnificent root of *Adiantum pedatum*, L., var. *rangiferinum*, Burgess and Macoun.

Rev. J. H. Keen, Metlakatla, B.C.—Specimens of *Gentiana Douglasiana*, Bong., and rare insects from northern British Columbia.

Mrs. D. W. Stewart, Renfrew, Ont.—Living roots of violets and specimens of *Medicago falcata*, L.

Mrs. Stoker Cowichan Lake, B.C.—A large collection of the seeds of 147 species of Vancouver Island plants.

Dr. Douglas G. Storms, Hamilton, Ont.—Roots of *Trillium grandiflorum*, Salisb., abnormal form with green flowers.

E. P. Venables, Vernon, B.C.—Local plants from Vernon, B.C., including *Cynoglossum occidentale*, Gr.

Rev. Frère Marie Victorin, Longueuil, Que.—Specimens of *Butomus umbellatus*, L., and *Sambucus Ebulus*, L., first found growing wild in Canada by the sender.

Correspondence.—The correspondence of the Division has shown a considerable increase over that of previous years, and the number of subjects inquired about has shown that the Division is becoming well known as a source of information with regard to all matters relating to the scientific consideration of insects and plants in connection with agriculture and horticulture. The number of letters exclusive of circulars entered in the Division register, as received from April 1, 1907, to April 1, 1908, was 4,030, and the number despatched 3,640. Articles relating to outbreaks of insects, the treatment of well-known pests and the best methods of dealing with noxious weeds have been prepared for local newspapers and for agricultural journals, whenever required. Many of these have been at the request of correspondents who have intimated that they were of general interest.

Meetings.—Meetings of farmers' institutes and other agricultural associations, teachers' associations, &c., have been attended by the Entomologist and Botanist whenever other official duties would permit.

June 7, 1907: Annapolis Royal, N.S.—A convention of fruit growers to consider the best measures to adopt to control the Brown-tail moth. An address was given on the habits of this insect and its history in America. A full and interesting discussion was carried on, and much information elicited with regard to the localities where it had occurred in Nova Scotia, and the vigorous steps which were being taken by the Provincial Secretary for Agriculture for Nova Scotia.

June 23 and 24: Boston, Mass.—By invitation of the legislative committee of the Commonwealth of Massachusetts, through Mr. A. H. Kirkland, Superintendent for suppressing the Gypsy and Brown-tail moths and with the approval of His Excellency Governor Curtis Guild, Jr., I was invited to be one of fourteen entomologists, from all parts of the world, to inspect and report upon the extensive work which had been done in the New England States in fighting against the Gypsy and Brown-tail moths, and particularly with regard to the importation of parasites of these insects from Europe. On June 24 I visited the laboratories at Saugus, Mass., with Superintendent A. H. Kirkland, and the following day, in company with Prof. John B. Smith, State Entomologist for New Jersey, Dr. E. P. Felt, State Entomologist for New York, Mr. Kirkland and Mr. F. H. Mosher, we covered a great deal of ground in an automobile and examined the work which had been done in clearing street trees, parks and woodlands from these aggressive enemies. The success of this whole movement, both in fighting against these caterpillars by the ordinary means and by the extensive importation of parasites, has been so remarkable that I was much pleased to have this opportunity of examining into the details of the work in the company of the experienced entomologists above named. The whole work forms without doubt the most remarkable experiment which has ever been tried in economic entomology. That in only two seasons 8,000 miles of streets should have been practically freed of devastating caterpillars of two of the worst known pests of shade trees, is a triumph of applied

science which must be of great encouragement to all engaged in such work, and is an indication of what may be hoped for in the near future in Massachusetts, if the same plan of action is persisted in under the same capable and energetic management. The systematic colonizing of parasites of these pests has been carried on under the direction of Dr. L. O. Howard, the United States Entomologist, and the condition of affairs at the present time is very hopeful and demonstrates the wisdom which has been shown by Superintendent Kirkland and Dr. Howard in carrying out this vast experiment. During last year over 100,000 parasites of different forms, chiefly *Pteromalids* and *Tachinids,* were liberated, and there are evidences that many of these are successfully established and that they are working on the insects for the control of which they were introduced. At the present time the field work is going on with a large measure of success, and the people of the State are well satisfied with it as well as with the work of introducing parasites.

July 4: Guelph, Ont.—Summer meeting of the Entomological Society of Ontario. Addresses on 'The Control of the Brown-tail and Gypsy moths in America, with special reference to the Importation of Parasites,' and 'Nature Study as a means of Education.'

July 12 to 31 in Manitoba and the Northwest Provinces:—

July 12 to 15, Aweme, Man., visiting Mr. Percy Criddle at St. Alban's, near Aweme, with Dr. Henry Skinner, of Philadelphia. Collecting insects and plants, at Aweme and in the Douglas sand-hills, where many valuable and interesting specimens were secured.

July 16: Brandon.—Visiting Experimental Farm.

July 17: Regina.—Examining the country around Regina with Mr. Willing. In the evening held a meeting of the Northwest Natural History Society in the Provincial Museum. Address 'The Practical Value of Natural History Studies.' This was the first of a series of meetings held by Mr. T. N. Willing, the Chief Provincial Weed Inspector, Dr. Henry Skinner and myself, at which addresses were given upon weeds and their eradication, the interpretation of the Weed Ordinance and the part played by insects in the transmission of various diseases.

July 18.—Left Regina for Hanley, where a well attended meeting was held in Rollefson's store, Mr. D. McLean in the chair. Questions were asked as to the treatment of Hare's-ear Mustard and Skunk-tail grass. The value of summer fallowing was also discussed.

July 19.—Left Hanley and drove to Rudy, where a good meeting of about forty was held at 3 p.m., Mr. William Duncan in the chair. On account of the heat this meeting was held outside the stopping place.

July 20.—Left Rudy at 9 a.m., and drove to Tessier, 27 miles. Stayed with Dr. Tessier, who had gathered together about 50 farmers from this new and exceedingly rich district. The meeting was held out of doors in the evening, and was prolonged on account of the many questions until a late hour. Keen interest was shown in the subjects treated of.

July 21.—Started from Tessier at 8 a.m., and drove 54 miles into Saskatoon. The crops throughout this whole district were excellent, and the country is settling up quickly.

July 22: Saskatoon.—A meeting was held at 1.30 p.m., Mr. John Ashworth in the chair. In the afternoon we took train for Duck Lake, where a meeting was held in the evening.

July 23.—Drove from Duck Lake to Skipton School, 25 miles, which was reached by 3.30 in a heavy and severe hailstorm. After the meeting we drove on to Parkside, another 14 miles, for the night, where we were kindly put up by Mr. George Alamanofski.

July 24.—Drove from Parkside to Shellbrook, 12 miles, where we held a meeting in the afternoon, which was not very well attended, owing to a heavy rainstorm. We left Shellbrook in the evening at 7 a.m., and drove into Prince Albert, 32 miles, through the sand hills, arriving by midnight.

July 25.—Left Prince Albert at 10 a.m., and drove 48 miles to Kinistino, where a good meeting was held in the evening, in the main street of the town. At this meeting several ladies were present, and many questions were asked about insects injurious to crops.

July 26.—Took train to Star City, where a small meeting was held at 3 o'clock in the afternoon.

July 27.—Took train for Prince Albert, arriving soon after noon. In the afternoon we drove out to hold a meeting at Birson, and afterwards visited the Weed Inspector, Mr. George Connors.

July 29.—Left Prince Albert for Warman, where a good meeting was held in the afternoon in the implement shed of the Saskatchewan Trading Company. Most of those present were Mennonites. We left Warman at 3.20 for Radisson.

July 30.—Collecting on the sand hills at Radisson in the morning, and in the afternoon at 2 o'clock, a large meeting was held with Mr. George Langley, M.L.A., in the chair. We left the same afternoon, and arrived at Lloydminster before midnight.

July 31: Lloydminster.—A large meeting was held in the afternoon, Mr. Jones in the chair. In addition to the other subjects usually spoken of at these meetings, the value of Brome grass was discussed. Seeing the lack of good hay in the district, I urged the settlers very strongly to cultivate this valuable grass, which is not only a source of a very large supply of succulent and highly nutritious fodder and hay, but is very early and also bears late into the autumn. It was explained that this grass had been introduced and was still highly recommended as a source of feed for stock. Many adverse reports which were made against it, were by those who had found trouble in keeping it out of tree plantations, or who did not want to give the proper amount of work to cultivating their land. Awnless Brome grass is a succulent vigorous-growing perennial grass which roots deeply and therefore is rather troublesome to eradicate when the land is required for other crops; but it produces more hay and of higher quality than almost any other grass that can be cultivated. It is specially suited for the soil and climate of the Northwest, where in many places grass is one of the most desirable crops. The seed is easily threshed and handled and has a ready market. Many of the farmers in the Northwest have told me that they owed their prosperity mainly to this grass. The difficulty of eradicating it from the land is, I believe, much exaggerated, and those who have tried it find that they can destroy Brome sod by breaking and back setting in the same way as the native grasses on the prairie. When it is wished to renew a piece of Brome pasture or meadow, this may be ploughed shallow in autumn or early spring, which, as the grass is very deep-rooted, stimulates growth and renews the stand. In districts where the soil is light and apt to blow, there is no better way of putting humus and fibre into the soil than by growing a crop of Brome; and, from a careful consideration of this question, I am convinced that no farmer in the Northwest can afford to condemn Brome grass on the dictum of other people; but should try a small patch of this valuable grass on his farm. Where farmers think more of their ornamental tree plantations than of their farm crops, or if they can make more money out of growing trees, the conditions of course are different, as undoubtedly Brome grass or any other plant growing among trees will rob them of moisture and stunt their growth. This meeting was the last of the series. The meetings were well attended throughout, and a keen interest was shown in the subjects treated of. Mr. Willing's extensive knowledge of farming conditions and farm practice in all parts of the Northwest made him a valuable source of reference to all who wanted information on these matters. Dr. Skinner delighted the audiences with his clear and definite presentation of his subject. He showed the great danger of allowing house flies free access to houses or places where food was kept, and explained the method of transmission of diseases by the various kinds of mosquitoes which carry yellow fever, malaria, &c. He also dealt with other blood-sucking insects, and showed conclusively the value of a knowledge of insect life both to farmers and to dwellers in cities. My own addresses

dealt with the particular farm weeds prevalent in the various districts visited, the agricultural treatments best suited for their control and the answering of questions concerning special pests, both plants and insects.

August 2: Banff, Alta.—Collecting and examining the collections in the Banff National Museum with Mr. N. B. Sanson.

August 3, 4: Laggan, Alta.—Collecting around Lake Agnes and on the mountains around Laggan, where many rare plants and insects were secured.

August 6: Vancouver.—Inspecting the fumigating station. Left for Victoria the same evening.

August 8.—Left for Duncans with Mr. Tom Wilson to inspect work done for the Department of Indian Affairs in clearing the Indian orchards of pests which it was alleged were a danger to the orchards of the white settlers. We were accompanied by Mr. W. M. Robertson, Indian Agent for the Cowichan Agency, who was of much use to us when treating with the Indians.

August 9.—Returned to Victoria. Consulted with Mr. A. W. Vowell, Indian Superintendent for British Columbia, as to carrying on the work in the Indian orchards for the future.

August 10.—Had a conference with the Hon. R. G. Tatlow, Minister of Agriculture, and afterwards with the Premier, the Hon. Richard McBride, with regard to the work which was being done in the Indian orchards.

August 11.—Left for Agassiz, which was reached the same night.

August 12.—Visited Sir Arthur Stepney's hopyards, where a remarkable outbreak of a flea-beetle, *Psylliodes punctulata,* Melsh., has been doing much harm for several years. Left for Kamloops and reached there at 6 o'clock the same evening.

August 13.—Visiting orchards and giving advice on the treatment for Codling Moth, of which there is a rather severe outbreak at Kamloops. There was to have been a meeting of the Fruit Growers' Association at this place, but through some misunderstanding it had not been arranged for. We were, however, able to meet several of the fruit growers. Left for Revelstoke the same evening, and the next day proceeded to Kaslo.

August 15: Kaslo.—Visiting orchards all day with Mr. J. W. Cockle, who had been making investigations into the life-history of the Codling Moth in this locality, and had also treated carefully a few trees which had been found to be infested by the San José Scale the previous year. It was satisfactory to find that, although the Codling Moth was abundant, the San José Scale was entirely destroyed on the treated trees, and not a single specimen could be found in the locality. In the evening a well attended meeting was held in the town hall, and a great many questions were asked concerning the cultivation of fruit trees, and the insect enemies most likely to occur in the Kootenays.

August 19: Nelson.—A large meeting of fruit growers was held in the town hall, at which many matters relating to fruit growing were discussed, and particular attention was paid to the insect pests occurring in the Kootenays and those which it was thought might possibly be introduced. Mr. Anderson detected the Codling Moth at Nelson during this visit; so, special attention was given to it, and the proper steps to control it were explained.

August 23: Indian Head.—Visiting the Experimental Farm and farms in the neighbourhood with Mr. Angus Mackay, the Superintendent of the Experimental Farm.

October 31-November 1: Guelph, Ont.—The annual meeting of the Entomological Society of Ontario. Presidential Address: 'The Entomological Outlook.' 'The Entomological Record, 1907.'

November 15: Toronto.—Annual convention of the Ontario Vegetable Growers' Association. Address: 'Insects that trouble vegetable growers and how to combat them.'

December 19.—Macdonald College, Ste. Anne de Bellevue, Que.—Meeting of the

Pomological and Fruit Growing Society of the Province of Quebec. Address: 'Insects injurious to fruit and vegetable crops in Quebec province during 1907.'

December 26 to January 3: Chicago, Ill.—Attending the meeting of the American Association for the Advancement of Science; the Association for the Advancement of Agricultural Science; the Entomological Society of America, and the Association of Economic Entomologists.

February 4: Ottawa.—Canadian Seed-Growers' Association. Address: 'The place of the Canadian Seed Growers' Association in the campaign against farm weeds.'

Mr. Gibson also attended the annual meeting of the Entomological Society at Guelph, and took an active part in the proceedings, giving in the various discussions much useful information, which was very acceptable to the meeting. Mr. Gibson also read a paper on 'An unusual outbreak of Halisidota Caterpillars.'

Acknowledgments.—It is again my pleasant duty to gratefully acknowledge my obligations to my many correspondents in all parts of the Dominion, to practical farmers who have much aided the work of the Division by promptly reporting outbreaks of injurious insects and noxious weeds, by sending specimens for examination and for our collections, and also by making observations upon points of special interest. My thanks are also specially due to many eminent specialists who have helped by giving us the exact identifications of specimens of plants and insects which were unknown to us. Among these, special mention may be made of the following:—

Prof. John Macoun, of Ottawa; Prof. W. G. Farlow, of Harvard University; Prof. L. R. Jones, of Vermont; Dr. P. A. Rydberg, of New York, and Dr. William Trelease, of St. Louis, for giving me their opinion on some doubtful plants.

Dr. L. O. Howard, Chief of the Bureau of Entomology, Washington, U.S., and the specialists on his staff, for the identification of insects in little known orders.

Dr. J. B. Smith, New Brunswick, N.J., who has examined and reported upon hundreds of noctuids and other moths for this Division and for Canadian collectors.

Mr. W. D. Kearfott, of Montclair, N.J., who has been of great service in naming microlepidoptera.

Mr. W. H. Harrington, Ottawa, for identifying coleoptera and hymenoptera.

Dr. E. M. Walker, Toronto, for examining and reporting upon many specimens of Canadian odonata and orthoptera.

Sir George Hampson, Bart., of the British Museum, has kindly examined several specimens and compared them with the series in the British Museum, not only for this office but for many other Canadian students.

In conclusion, I have again much pleasure in acknowledging publicly the good work which is being done by my assistants, Messrs. J. A. Guignard, Arthur Gibson and J. Létourneau.

I have the honour to be, sir,

Your obedient servant,

JAMES FLETCHER,

Entomologist and Botanist.

DIVISION OF ENTOMOLOGY

CEREALS.

The season of 1907 in all parts of the Dominion will long be remembered for its unusual and irregular character. From the Atlantic to the Pacific the spring was cold, dry and very late. Insects of all kinds were exceptionally scarce and the paucity of insect life in April and May had a direct effect on bird life as well as in many places also upon fruit crops. The amount of fruit set was noticeably smaller where there were no colonies of bees kept in the vicinity. The exceptionally backward nature of the season continued throughout the summer and affected seriously the development and ripening of all crops. This was only partially compensated for by a long open autumn without severe frosts. In the wheat-growing districts the crop was, however, in many places injured by this exceptional season and this was particularly the case in the prairie provinces.

The grain crops in the Northwest provinces were poor and light in quantity owing to the very unusual season, but the much higher price paid for grain than in previous years brought much money into the country and relieved the farmers from much of their loss. In British Columbia very little spring wheat was grown owing to the presence in previous recent years of Wheat Midge. Fall wheat yielded fairly well.

THE HESSIAN FLY, *Mayetiola* (*Cecidomyia*) *destructor*, Say, occurred in the Maritime Provinces in several localities, but only in Prince Edward Island was noticeable injury reported. There is evidence that this troublesome insect is again gradually increasing in Ontario, and as it is working westward in the northwestern United States it must at some time be expected to appear in our Alberta fall-wheat districts; it will be well therefore for farmers to be on the alert and apply vigorously the well known remedies which, briefly, are as follows—

Late Sowing of Fall Wheat.—This is the most important preventive remedy and means a change from the ordinary farming practice and for this reason it is sometimes rather difficult to persuade wheat growers to adopt it. By postponing seeding until the end of September the appearance of the young wheat plants above the ground in autumn is delayed until after the egg-laying flies, which emerge in August and September are dead. The chief objection offered to sowing so late as the end of September is that plants have not time to make vigorous roots so as to withstand the cold of winter. This danger, however, experiment has shown is not so great as it appears, and if the land is got into good condition and good heavy seed is sown by the end of September, it will generally give a satisfactory crop.

Burning Refuse.—Many of the flax-seed-like pupæ of the summer brood are carried with the straw and at threshing time are loosened and fall beneath the machine with the rubbish, or they may be left in the straw. All dust and screenings therefore from the threshing mill should be carefully destroyed or fed, and all straw and small seeds should be either used during the winter or burnt before spring.

Treatment of Stubble.—Most of the flax-seeds of the summer brood are placed so low on the stems that they are left in the stubble when the wheat is cut. A large proportion of these produce flies in September but some pass the winter in the stubble. Stubble should therefore be ploughed down deeply so as to place the insects so far beneath the surface that the delicate flies when they emerge cannot escape.

Trap Crops.—A method of reducing the numbers of Hessian Flies which is little practised, but which is spoken highly of by some, is sowing narrow strips of wheat in

August, which will attract the females to lay their eggs; these strips must afterwards be ploughed down before the larvæ are mature when they will be killed, and the wheat which is sown late will escape owing to the egg laying females having all deposited their eggs. This end may also be obtained by running a harrow over the stubble as soon as the crop of fall wheat is cut so as to start a volunteer crop from the grain which had been shelled out in harvesting. This volunteer crop will form an attraction to the females before the main crop appears above the ground and can be ploughed down deeply at any time before the larvæ mature.

Reports of injuries by Hessian Fly from Manitoba proved upon investigation to be unfounded.

WHEAT-STEM SAWFLY, *Cephus occidentalis,* Riley & Marlatt.—This insect which has been referred to occasionally in previous reports of the Division, last autumn appeared in central Manitoba and the eastern part of Saskatchewan, in much more serious numbers than at any previous time. The broken down straws which resulted from its attacks were seen in many fields and caused some alarm. Among correspondents who reported on this insect, Mr. Norman Criddle, an observant farmer and student of insects, living at Aweme, Manitoba, writes at the end of the season as follows:—

'This native species of sawfly which until the breaking up and cultivation of the prairies was confined to a few native grasses belonging to the genus *Agropyrum,* of which *A. caninum,* R. & S. here is the favourite, has increased considerably during the last year or two. In the absence of parasites this insect seems to have been controlled by the number of flowering stems formed by its food plant, the grass in its turn being restricted by the climatic conditions of the season, so that an unfavourable season for the grass to form flowering stems would also prove unfavourable to the increase of the sawfly; but with the cultivation of the prairie and the planting of cereals the conditions change. For, although native grasses seem still to be preferred, yet if on account of the season, as is sometimes the case, they fail to develop stems abundantly or the insects are too numerous for the stems of the grasses produced, the flies turn their attention to wheat or rye, as well as to the western rye grass, *Agropyrum tenerum,* Vasey, which is now so extensively grown in Manitoba, causing serious damage to that important crop. These conditions occurred in 1907 with the results that in some cases fully 50 per cent of the wheat stems were broken down around the edges of fields, extending in to a distance of 100 feet or more, and damage was apparent to a lesser extent all through the crop. An interesting feature in connection with this attack upon wheat, was that fully 75 per cent of the infested stems were broken down by wind about 2 or 3 inches above the ground, close to where the larvæ were at work; and in many instances an examination showed that the larvæ had been caught by the breaking of the straw, some actually at the broken spot, when they were pinched to death, while in others they were above the break, which proved equally fatal to them. I calculated that on a certain area fully 12 per cent were killed in this manner. It is interesting to note that the native grasses, however, never break in this way, so that in attacking wheat the insect has to contend with conditions which, though favourable to its increase, are not so much so as an abundance of its native food plant would be. The life history, so far as I know it, seems to be about as follows:—The eggs are laid singly upon a stem of grass or wheat, not far from the head, between June 20 and the second week of July. The larvæ soon hatch and begin to eat down inside the stem, usually reaching maturity and the ground towards the end of August. They then eat the stems almost through, slightly below the ground, so that they break off. The stubs are then closed over with a water-tight material and the insides of the stems are also lined by the larvæ to the roots. In these retreats the larvæ pass the winter and remain in an active condition unchanged until May of the following year, when they turn to pupæ and emerge as perfect sawflies towards the end of June, the date varying somewhat with the season.'

In my previous reports from observations I had made on material sent to me I had suggested that an important remedy in controlling this insect would be the burning over of stubbles, but from Mr. Criddle's observations it would appear that the winter location of this insect below the surface of the ground would protect it so thoroughly as to render this practice almost useless. At my request Mr. Criddle made special observations on this point. He writes:—

'Aweme, October 6, 1907.—At your suggestion I have just made experiments with burning stubble to see what its effect would be upon *Cephus occidentalis*. As the stubble was too thin to burn freely, and to make sure of having the experiment complete, I spread an infested piece of ground with four inches of straw and then set fire to it. This burnt decidedly longer than the thickest stubble would do and heated the ground on the top, so that it was unbearable to the hand. After it was cool I examined the inhabited straws, and though in some cases the top of the stubble cut off by the larvæ had been burnt, in no instance was a single larva found injured, but in every case they were found at the extremity of their burrows near the roots of the plants, showing that the heat had merely had the effect of driving them downwards, and as their tunnels in the straw usually extend from one to two inches below the surface, they would practically be uninjured by this treatment.'

The Wheat-stem Sawfly undoubtedly occurs in many places where its presence is overlooked, but correspondents in Manitoba and the Northwest make frequent reference to an injury in wheat fields which can only be referred to this insect. The remedy which suggests itself and which has been practised to some extent is the ploughing down of all stubbles either in autumn or before June 15, at which time the mature insects may be expected to emerge. Mr. Criddle also suggests that all grasses belonging to the genus *Agropyrum* growing around the edges of fields should be mowed down during the last two weeks of July, so as to destroy any contained larvæ.

Wheat Joint Worm, *Isosoma tritici*, Fitch.—There is every year considerable loss in the wheat crop of Prince Edward Island from the Wheat Joint Worm, and some correspondents believe that the insect is spreading quickly throughout the province. Father Burke, of Alberton, who has many opportunities of examining the crops, believes it to be a serious matter, and regrets that more of the farmers do not consider it specially with a view to adopting concerted measures for its control. The adoption of a regular short rotation of crops and the mowing down of all grasses along the borders of fields in June, as well as the keeping up of the fertility of the soil, so as to produce a healthy vigorous growth, will not only discourage egg-laying by the Joint Worm but will have many other beneficial effects on the land where these wise measures are practised.

'Lower Montague, P.E.I., July 30.—I send you a few stalks of Laurel wheat. This crop was sown on May 19, and appeared to be all right and looked splendid until lately. On examining it I find a great many crooked straws similar to those which I send. I have never seen this before. I have a field of White Fife wheat which was sown on the same day as the Laurel, and this is very little affected.—MONTAGUE ANNEAR.'

'Stanley Bridge, P.E.I., August 3.—The Joint Worm has totally destroyed all the wheat in this vicinity and is spreading rapidly. As yet farmers have made no effort to fight the pest. Will it take oats and barley if we give up growing wheat?—A. J. MCNEILL.'

'Bay View, P.E.I., March, 1908.—In reply to your question, the Joint Worm of wheat was first observed in our district in northwest Queen's county, at Long River, about five years ago. The next season it had spread five miles along the shore. The remedies recommended were not applied, as the farmers on the Island seed down all their wheat land with clover and grasses, and firing the stubble would destroy their hay crop. In 1907 the pest had spread from Kensington along the shore to beyond Rustico, a distance of over thirty miles, and some nine miles inland. All wheat

seeded before June 3 was attacked, and practically all was ruined, and later seedings although free from the pest gave light crops of soft wheat. Parasites have not been observed as yet, and there seems to be a steady increase in the numbers of this very serious pest of our wheat crop. I may mention that I saw Joint Worm flies on the wing on May 23.—J. A. CLARK.'

Specimens of the galls were sent from Prince Edward Island and such of the flies as were reared proved to be the Wheat Joint Worm, *Isosoma tritici*, Fitch, but from the difference in the appearance of the galls it would seem likely that another species was also at work on wheat in Prince Edward Island. No specimens of *Isosoma hordei*, Harris, were received, nor were there any complaints of injury by joint worms to barley. It is not likely that the Wheat Joint Worm will attack either barley or oats. There is apparently only one brood of the Wheat Joint Worm in Canada, the larvæ of which winter in the straw, for the most part so near to the ground that when the crop is cut the greater portion of them are left in the stubble. It has been recommended as a remedy for Joint Worms to burn over the stubble or to plough it down deeply for the destruction of the contained larvæ, and the disposal by burning or feeding of the galls or hardened portions of the straw which become separated in threshing. There is great variation in the extent of the swelling which results from the attacks of these larvæ. Frequently the galls are hardly noticeable, but the tissues of the stem are thickened and become brittle so that they break from the rest of the straw when threshed. These and all straw from an infested crop should be either fed or burnt before the ensuing spring. As is pointed out above by Mr. Clark, the farmers of Prince Edward Island are getting into the way of seeding down their wheat lands with clover and grasses, so that either burning of stubble or ploughing down cannot be adopted where the land is to be left in hay. A more extensive cultivation of clover than has been the practice in the past in Prince Edward Island is highly desirable, but while the Wheat Joint Worm is abundant and increasing in destructiveness, some modification of the ordinary practice is decidedly advisable and the benefit of sowing clover as a nitrogen-gatherer, might still be preserved to a large extent by sowing a few pounds of clover seed with all grain crops and then ploughing this down with the stubble either in the first autumn or the following year. In fighting against insects it frequently becomes advisable to modify accepted agricultural practices so as to control a pest which has become unusually abundant at a special locality. By examining the stubble of an infested crop of wheat it could soon be seen whether or not the galls were located near the base of the stem or so high up that they would be carried with the straw. The location of the gall will vary with the season in the same way that the point of attack by the Hessian Fly varies. In late cold springs the attacks of both of these insects are lower down, in the case of the Hessian Fly being sometimes entirely confined to the root shoots, while in other years the larvæ may be found one or two joints up the stem from the base.

It is important that the farmers of Prince Edward Island should now come together and discuss methods of prevention for this insect, so that some wholesale, vigorous and concerted action may be taken to prevent the further increase of this insect which is now becoming of importance to the whole Island.

The perfect insect of the Wheat Joint Worm is a minute, shining, black, four-winged fly, only one-tenth of an inch in length with clear wings and pale legs. The larvæ are slender, footless grubs, one-eighth of an inch long with perceptible brown jaws. These occur only inside the galls on the stem and vary in number from 4 or 5 to as many as a dozen in a single gall. The galls as a rule occur just above the first or second joint above the root. Nearly all of the larvæ winter unchanged inside the galls, but occasionally a small proportion change to flies and emerge late in autumn.

The Grain Aphis, *Macrosiphum granaria*, Kirby.—There was an unusual amount of interest and considerable alarm in the Northwestern provinces last summer concerning grain plant lice and several letters were received asking if specimens sent were the so-called 'Green Bug' which was causing such a great sensation in the

States to the south of our border. Actual specimens of this insect, *Toxoptera graminum,* Rond., were received from Emerson, Manitoba, but these had merely spread over the border from an infestation a few miles to the south in Minnesota and did no harm in our wheat fields. There were, however, serious complaints of injury in Manitoba and the eastern part of Saskatchewan from the ordinary Grain Aphis, *Macrosiphum granaria,* Kirby, a somewhat similar insect but one which is easily distinguished from it by the venation of the wings when examined under a magnifying glass. There are four plant lice which injure wheat in the west. (1) The Spring Grain Aphis, or so-called 'Green Bug' which for the most part attacks the leaves of the young plants, and which has the second vein from the tip of the upper wings only once forked or divided, and the small honey tubes at the end of the body above, of a pale colour with only the tips darkened. (2) The Grain Aphis, which has the second vein twice divided and the tubes black. (3) The Oat Grain Aphis, *Siphocoryne avenæ,* Fab., also called the European Grain Aphis, which in the winged form has the second vein forked, but instead of being divided at the tip so that the first fork from the tip leaves the main vein one-quarter of the way from the end, it is only about one-eighth of the distance, thus leaving the cell at the tip of this vein very small. The tubes at the end of the body are distinctly broader at the base than toward the apex. The eyes are reddish as in the Grain Aphis and the front of the head is not pointed in which it agrees also with the last named species. The two last named plant lice although they occur upon the leaves of the small grains during part of their life-history are much more apt to cluster together on the heads as soon as these are formed, while it is stated that the Spring Grain Aphis only attacks the leaves. Prof. Washburn states distinctly, 'Toxoptera was never found according to the reports of our field workers on the heads of any of its food plants, differing in this respect from *Macrosiphum granaria* which attacks the heads as soon as they appear.' (4) The Apple Aphis, *Aphis mali,* Fab. This species does not feed the whole season on the plants of the various small grains but migrates to them during the summer time from apple trees, the winter being passsed in the egg condition on the branches of apple trees in a similar way to that in which the Hop Aphis winters on plum trees. After four or five generations on apple trees in the spring, winged migrants are produced all of which fly to the grain fields and at once produce large numbers of wingless young, all of which are females. These towards the end of the season produce perfect males and females, which, after mating, deposit the winter eggs on apple trees.

The injuries by the Spring Grain Aphis have been more pronounced in the southern districts of the United States; but the species has spread northward in injurious numbers almost to our borders. The chief check on the excessive increase of this pest in the United States has been the sudden appearance in large numbers of a minute parasitic wasp, named *Lysiphlebus tritici,* Ashm., which not only destroys this grain aphis but also all other species found in grain crops. It is fortunately present in large numbers in all the districts from which grain plant lice were sent last summer. The injuries by the ordinary Grain Aphis, *M. granaria,* were in some places severe, being reported in July, August and September. These injuries were chiefly in the west.

'Welwyn, Sask., August 26.—I send specimens of a green aphis and some heads of wheat showing the way in which they feed. Seemingly they suck the sap out of the base of the grain where it is attached to the stem. Is this the same as the green bug they have in the Western States? They are doing the grain fearful damage, as they are in millions. So far I have only seen it on breaking. I have not heard of any other fields in this neighbourhood, and I only discovered them on my own three days ago.—Ranald Stewart.'

'Welwyn, September 10.—I send you some more wheat and bugs. I have found no parasites. The bugs are not as plentiful as they were three weeks ago and summer fallows seem to be free. I have just heard to-day that there are hundreds of acres about 30 miles northeast of here which are not worth cutting. Two farmers there

have 200 acres of wheat, and out of that they are only going to cut 35. I think the damage is more widespread than people have any idea of. I have put my own loss at 15 per cent of the crop and probably more, but we have had two heavy rains since these bugs appeared, and this seems to have washed many of them off.—RANALD STEWART.'

These specimens sent by Mr. Stewart were at first thought to be the dreaded 'Green Bug,' but winged specimens were afterwards received and they were found to be the Grain Aphis. Specimens of the same species were also sent from localities in Manitoba, mostly from the west of the province. Parasites were reared in numbers from all the material sent, including that from Welwyn.

Unfortunately for the Grain Aphis there is no practical remedy which can be applied in a wholesale manner, but Prof. F. M. Webster, who has devoted much attention to the insects which attack grain crops, has constantly drawn attention to the great advantage of practising good agricultural methods in working land, such as the adoption of a regular rotation of crops, so as to keep up the fertility of the soil, and advises that care should be taken to sow grain at the best time to secure a vigorous growth, which will enable the plants to withstand the attacks of the aphis sufficiently long to allow the natural parasites which always sooner or later appear, to increase, so that the numbers of the plant lice may be reduced before serious injury is done to the grain plants. In the case of the Oat Grain Aphis and the Apple Aphis, the two commonest species in Ontario and the east, as these pass the winter in the egg condition upon apple trees the regular spraying of apple orchards with kerosene emulsion or the lime and sulphur wash would not only clear those trees of enemies which sometimes do much harm but, also, to a large measure protect the wheat fields the following season. Fortunately for the wheat grower a severe outbreak of grain plant lice is almost invariably accompanied by a rapid increase in the numbers of various parasitic and predaceous enemies, which as a rule prevent serious losses.

GRASSHOPPERS, *Melanoplus* spp.—Locusts, or as they are more generally spoken of as grasshoppers, were injuriously abundant in some places in eastern Ontario and along the Quebec shore of the Ottawa river. A great amount of injury was done to pastures and all growing crops. Large swarms of the ordinary species which are common in Ontario also occurred in many places in western Ontario, where injury was done not only in field crops but in vineyards and orchards. The species sent in were *Melanoplus femur-rubrum*, DeG., *Melanoplus atlanis*, Riley, and *M. bivittatus*, Say. In Manitoba the same species were all present and destructive as well as *M. packardii*, Scudd., and *Camnula pellucida*, Scudd., was destructive in British Columbia. The following letters chosen from many received show the extent of injury by some of these swarms and the time they appeared:—

'Kamloops, B.C., May 31.—Please send the latest information on fighting grasshoppers. They took my crop last year and are now hatching in great numbers. I have just put out Paris green and salt mixed with horse manure and a little water. My neighbours have tried this also, but they tell me the grasshoppers will not eat it.—J. P. SHANNON.'

'Treesbank, Man., August 16.—Grasshoppers are decidedly on the increase again, and with favourable conditions I fear that they might be as bad as ever in a year or two. We shall, however, watch them and try and put out the poisoned horse manure if they attack the crop.—N. CRIDDLE.'

'Neepawa, Man., September 7.—I send specimens of grasshoppers which are most unusually numerous this fall in this vicinity. They were never seen so thick before. I am wondering if they are the forerunners of a grasshopper plague next summer. Is there any danger from their laying eggs which will hatch next spring? If so what is the best thing to do?—E. T. MOODY.'

The species sent by Mr. Moody was the Two-striped Grasshopper, a large heavy species, which as a rule is found in rather low ground near bushes, and is not so often injurious to crops as some of the smaller and more active species.

'Pointe du Lac, Que.—I send specimens of grasshoppers which are actually destroying the crops in our district. We have tried the Criddle mixture, but it has not had an appreciable effect on their numbers.—Rev. J. CARON.'

'Galetta, Ont., July 17.—Please give a remedy for grasshoppers. A very large army of them has attacked a field of oats having come from a large adjoining pasture. I have tried Paris green on a ridge without effect.—MATTHEW RIDDELL.'

'Ballantrae, Ont., Aug. 22.—Seeing that various reports are going in with regard to the grasshopper plague I thought I would tell you how we were faring in this part of the province. I live on the ridges of the township of Whitchurch, county of York, and our soil here for the most part is a sandy loam. The grasshoppers struck this locality early in the season and we are suffering greatly from their ravages. Other localities escaped until later in the season, but they are becoming general and widespread now. They have taken all second crop and spring-seeded clovers. Pasture land is as bare and brown as a barn floor. Some farmers left their oats standing until completely stripped, others cut them in the milk, and they were half stripped even at that stage. The turnip crop is practically gone. In some cases the carrot crop is eaten level with the ground and their latest freak is eating out the mangel roots. Peas have escaped fairly well but some fields are nearly stripped of their foliage. Fodder corn is eaten in holes and they are boring through the husks and eating out the grain of the ear. They started about a week ago upon the potatoes and some patches are now bare. They cut the leaves off and drop them and the stalk is sometimes eaten through at the bottom and just falls over and dries up. Vegetables are entirely destroyed and raspberry, gooseberry and currant bushes are stripped bare. —W. A. QUANTZ.'

Last summer was extremely dry in many localities and where this was the case growth was slow and meagre and here the grasshoppers did most harm. In some places where copious rains came late in the season and vegetation of all kinds picked up the injuries by grasshoppers were much less apparent. Rev. Father Caron when writing in the middle of August from Point du Lac, Que., refers to this and speaks of his previously reported poor effects of the Criddle mixture of Paris green and horse manure in his parish, which he says the farmers did not use sufficiently to give it a fair trial because it did not show immediate results. This was the case also in many other places where the mixture was tried. There is evidence to show, however, that this mixture which undoubtedly gave most satisfactory results in Manitoba wherever it was tried has not proved so successful in some other places. Whether this is due to the climatic conditions I am unable to say, but in Manitoba the grasshoppers were destroyed in myriads and the mixture was remarkably attractive to them, so that they would flock to those parts of the field where it had been scattered and were poisoned by eating it. In Ontario on the other hand it would seem to be much less attractive to the species which occur commonly here. For these districts it may be remembered that the now well known poisoned bran remedy for cutworms (one pound of Paris green, one pound of salt and one gallon of water, in 100 pounds of bran) may be used and is extremely effective against grasshoppers of all kinds. In fact this mixture of Paris green and bran was originally devised in California as a remedy against grasshoppers in vineyards. The spraying of the edges of fields with arsenical mixtures when grasshoppers first begin to move towards crops has also been found very useful. Later when the insects have their wings and are occurring in large numbers a modification of the tin pans or light frame works known in the west as 'hopper-dozers,' may be used to great advantage. These are light frames with wings and a back covered with canvas and having a tin pan at the bottom which will hold tar or coal oil and water. These are drawn over pastures or in such places as grasshoppers are abundant and the insects are caught in large numbers. If a grasshopper has only a small drop of coal oil on its body it will soon spread all over it and be fatal.

PEA WEEVIL, *Bruchus pisorum*, L.—The Pea Weevil which for three years has hardly been mentioned in correspondence, is evidently again increasing in numbers

and it is of the greatest importance that pea growers and seed merchants should use vigorously the well-known remedy of fumigating all seed peas before sowing them, or, what is far preferable, as soon as they are harvested and threshed. One or two samples have been recently sent in which were as badly infested by the Pea Weevil as in the worst years four or five years ago. One of the important centres of the pea-seed trade is the county of Prince Edward in Ontario. A few years ago peas in that county were infested by the Pea Weevil to an extreme degree. Mr. J. D. Evans, of Trenton, who has kindly kept me informed regularly with regard to this infestation, reports on the season of 1907, as follows: 'I discusssed the matter of Pea Weevil injury with Mr. W. P. Niles, of Wellington, one of our best authorities, and he tells me that the Weevil is almost extinct in Prince Edward county at the present time, but owing to the carelessness of farmers in attending to their seed peas, he will not be at all surprised to see it again troublesome in the near future.' Mr. Niles said that he had received some peas from Oshawa which were somewhat infested but not very seriously; but he had, however, a sample from Exeter, in Lambton county, which was about as bad as it could be. The remedy above all others by which the Pea Weevil has been kept in check in the past is the scrupulous fumigation of all seed peas. There is still some confusion on the part of farmers as to what the Pea Weevil really is. This is to a measure due to the senseless persistence of merchants and farmers in speaking of it as the 'Pea Bug' and consequently as almost every insect is called a bug on this continent, as many specimens of peas injured by the Pea Moth are sent in as having been attacked by the Pea Weevil, as those injured by the insect properly so called. The injuries of these two insects are entirely different. The work of the Pea Weevil is inside the seed and after the small brownish gray beetles, one-fifth of an inch long and bearing two conspicuous black spots on the end of the body, have emerged, there is on the side of the pea a small perfectly round hole. The work of the caterpillar of the Pea Moth is an irregular ragged-edged cavity eaten in the side of the seed while it is green. The life-history of both of these insects is perfectly well known: The egg of the Pea Weevil is laid on the outside of the young green pod and the grub on hatching eats its way in and penetrates the nearest pea. Here it remains until full grown which is late in the summer time after the peas are ripe. When peas are threshed as soon as they are ripe and the seed is fumigated at once the grub of the Pea Weevil can be destroyed before it has eaten very much of the seed; but if left untreated until later in the winter or until just before sowing, the benefit is merely that the beetles inside the peas are killed. This is of much importance but if the work is done as soon after harvesting as possible the injury to the seed is reduced very much indeed. The larval life of a Pea Weevil is passed entirely inside the pea it first entered. The egg is laid during June and the small grub has to penetrate the pod and locate itself inside a seed before this becomes too hard. The development from a white fleshy grub to the pupal condition and the change to the perfect beetle, all take place during the late summer and some of the beetles are fully developed by about the middle of August, a few, in certain seasons, leave the peas in the autumn or even as early as harvest time; but the regular habit of the insect is for the beetles to remain in the seed until the following spring. Those weevils which emerge in the autumn pass the winter hidden away under rubbish or in barns, outhouses, &c. Occasionally there is a wholesale emergence in the autumn, and when this takes place the numbers of Pea Weevil are enormously reduced. They are exposed to many dangers which they would have escaped had they remained inside the peas. Insect eating birds and mammals destroy many, and I have been shown, near Picton, in Prince Edward county, Ont., thousands of the beetles which had crawled beneath the shingles of an old barn and had died there, presumably killed by the cold of winter. Those weevils which pass the winter safely outside, or those which have been sown in the spring with the seed peas, fly to the fields, and for some time feed on the foliage of the pea plants. As soon as the young green pods are formed the eggs are laid and the grubs hatch soon afterwards. There is only one brood of this insect in

the year, and the important fact in its life-history is that every pea containing a weevil, and this is by far the largest proportion of all the insects produced every year, is for a considerable time entirely at the mercy of the farmer or seed merchant, for there is no other known food plant for this insect than the cultivated pea. It is not a native of this country any more than its food plant is, and the pea is not one of those cultivated crops of which the seeds lie over and produce a volunteer crop the following year.

Remedies.—(1) Holding over seed. Of many remedies suggested that of easiest application and requiring no expenditure is the holding over of seed. Where only a few seed peas are used it is very easy to store these away until the second year after harvesting. Peas should always be bagged and the sacks tied up tightly at once after threshing. It has been found that the Pea Weevil cannot eat its way through bags even when these are made of paper. Therefore all the weevils which emerge either in autumn or the following summer will die inside the bags, and the seed can be sown the following year without danger. Sound seed will not be injured in the least by being held over for this time. Seeds which have been injured by the weevils will grow unless the germ has been destroyed, but such seeds produce only weak plants, which unless all conditions are extremely favourable, do not produce nearly as heavy a crop and should not be used for seed unless no others are obtainable. Of 400 seeds picked at random from a sample sent in last winter, all of which had been attacked by the weevil, only 34 grew:

a. 10 seeds germinated, 3 weak plants, 7 strong.
b. 9 seeds germinated, 2 weak plants, 7 strong.
c. 10 seeds germinated, 4 weak plants, 6 strong.
d. 5 seeds germinated, 3 weak plants, 2 strong.

This experiment merely confirms previous experiments which have been tried here on several occasions.

(2) Fumigation.—The standard remedy upon which chief reliance must be placed to control the Pea Weevil is the fumigation of all seed peas with bisulphide of carbon. For treating large quantities, specially prepared houses are maintained by the large seed merchants. These 'bug houses' are tightly constructed, and are made to treat from 1,000 to 3,000 bushels at a time. The treatment of smaller quantities, such as are required by farmers, is an easy matter, and an ordinary coal oil barrel is a convenient receptacle for the seed. A 40-gallon coal oil barrel will hold about five bushels, or 300 pounds of seed, which can be treated with 3 ounces of bisulphide of carbon poured right on to the peas and the barrel quickly closed up tightly. The bisulphide of carbon should be of the best quality which will vaporize entirely without leaving any residue. The time to keep the barrel closed is 48 hours. As stated above, the seed should be fumigated as soon as possible after harvest, but the work may be done at any time when the temperature is above freezing. It is well to mention that bisulphide of carbon is very inflammable; fumigating therefore should be done out of doors in a shed or at a distance from buildings, and no light of any kind must be brought near.

FRUIT CROPS.

The spring of 1907 was cold throughout the Dominion and very dry in the eastern provinces. This had a direct effect upon all fruit crops. The remarkable scarcity of insects of all kinds prevented the fertilization of much fruit, except in such orchards as were near to apiaries. The crop in Ontario, Quebec and the Maritime Provinces was not of very high quality, but good prices were obtained, particularly when grown under the best horticultural methods. At the Central Experimental Farm there was a full set of fruit owing to the number of bees which had access to the bloom. Prof. Hutt, of the Ontario Agricultural College at Guelph, drew particular

attention to this matter also at the last annual meeting of the Entomological Society of Ontario. Bees wintered poorly and many colonies were weak in spring. Prof. Hutt attributes the small set of fruit in some localities in Ontario in 1907, chiefly to the lack of domestic and wild bees, and noticed many instances where men who kept bees had better crops of fruit. In British Columbia the fruit crop was excellent and as good in quality as in quantity. In western Ontario the crop of grapes was large except in those districts where the Rose Chafer destroyed the blossoms. wing to the late cold season many kinds of grapes were not ripe when the frosts came. Small fruits produced poor crops owing largely to the drought. The crops of vegetables of all kinds were also much affected by the drought, and in the eastern portions of the province of Ontario and in parts of Quebec the potato crop was exceptionally poor. In some places the seed tuber remained in the ground without decaying until the end of the season.

Codling Moth, *Carpocapsa pomonella*, L.—Of the insect enemies of fruit crops some of the old enemies and well known pests were more than usually destructive. The Codling Moth in western Ontario was so destructive in some places that several fruit growers discussed seriously the advisability of cutting down their apple trees and planting grapes or peaches. This part of the province is within the area where there are two regular broods of the Codling Moth in the season, the latter of which is by far the more destructive. It therefore becomes necessary for fruit growers not only to spray their trees in spring but also to apply bands regularly as shelters for the larvæ to spin up in. This causes a great deal of work, and in this district grapes and peaches are considered the best paying crops. This fact I believe accounts to a large measure for the increase of the Codling Moth in the Niagara peninsula. The apple orchards are not given the same care as in other parts of the province and consequently some of the regular pests increase unduly. In this district three sprayings with poisoned Bordeaux mixture in spring and the banding of all trees in July and August are the means by which the apple, pear and quince crops should be protected from injury by the Codling Moth. Some care is necessary in attending to the bandages, or putting them on may do more harm than good. These bandages may be made of any soft material such as burlap, hessian, old sacking, &c., and can be quickly and easily attached to the trees by placing a piece of string or wire around the middle and then turning down the upper half. These bands should be put on the trees by the beginning of July and should be examined at least once a week for the rest of the season. During August a great many cocoons and larvæ will be found and these must be destroyed, for which purpose it will be necessary to remove the bandages. Later in the season the caterpillars will be fewer and the easiest way of killing them is with the point of a knife without removing the bandages. The caterpillars have the habit of boring some distance into the bark of the tree and spinning in the dust on the outside of their cocoons. This renders them extremely difficult to detect and I have found a convenient implement for cleaning the bark beneath the bandages is a wire brush such as is used for cleaning out furnaces. This tears the cocoons from the bark and destroys the contained larvæ.

A fact which is always apparent in orchards which are regularly sprayed year after year with poisoned Bordeaux mixture is that the effects are cumulative. Regularly sprayed orchards gradually become year by year freer from insects and fungous enemies, notwithstanding the fact that many insects are able to fly long distances and the spores of parasitic fungi may be borne easily almost to any distance.

The Oyster-shell Scale, *Lepidosaphes ulmi*, L.—Owing possibly to the inclement season the increase of the Oyster-shell Scale in the summer of 1907 was particularly noticeable and undoubtedly much injury resulted from its attacks upon fruit and other trees. The young of this insect hatch beneath the parent scale about the end of May or the beginning of June and are active for a few days only. They are then

very minute, six-legged mite-like insects which swarm over the trees giving them the appearance of having been dusted with some coarse white powder. By the second day most of the young scale insects have chosen a suitable place and have attached themselves to the young tender bark by means of their slender sucking tubes. There they remain for the rest of their lives, growing rapidly during June and July. Early in August the females have become little more than a bag of eggs beneath the waxy scale. The insect itself is crowded up into the narrow end of the scale where it dies, leaving the eggs to carry the species over the winter. The scales of the male are seldom noticed; they are most frequently found upon the leaves and are of an entirely different shape from those of the female, being elongated, square at the end and somewhat tapering to the front. They are very small not more than one-twentieth of an inch in length and pale in colour. Unlike the female which lives all its life inside the scale and has no power of motion after it once settles, the male is a minute two-winged fly which when mature emerges from beneath its scale and has the power of flying very rapidly.

Remedies.—The remedies for the Oyster-shell Scale are the invigoration of the tree by high culture and good orchard management and the direct treatment of the scale insects with contact insecticides. The young hatch about the beginning of June and as soon as these are noticed on the trees, whale oil soap solution, or kerosene emulsion, should be promptly applied as a spray. The sooner this is done after hatching has taken place the more effective it will be. Trees badly infested should be helped by having some quick-acting fertilizer spudded in around their roots in spring and in autumn should be sprayed with a lime wash made of one pound of quick lime in each gallon of water. Two applications of this weak whitewash should be made and the second one may be put on immediately the first one is dry. This spraying should be done as soon as the leaves fall or at any other convenient time afterwards before the intense weather of winter sets in. During the winter the lime flakes off and carries with it a large proportion of the egg-containing scales which have been loosened by the lime.

THE SAN JOSÉ SCALE, *Aspidiotus perniciosus,* Cmstk.—The condition of affairs with regard to the San José Scale in the orchards of Ontario is practically the same this year as it has been for the last year or two. This insect although it has spread to new orchards has not invaded new territory in the province. Owing to the late season of 1907 the appearance of the young was also later than usual and there is no doubt that the fruit growers of that part of Ontario where the scale occurs, now understand its habits and the importance of using the lime and sulphur wash which is the standard remedy. Mr. J. Fred. Smith, the San José Scale inspector for the province of Ontario, reports that never before has there been so much done for the destruction of the scale by fruit growers as during the past season. The lime and sulphur wash was the remedy mostly used. Mr. W. H. Bunting, a large fruit grower and a leading member of the Fruit Growers' Association of Ontario, stated in a lecture given at Ottawa last winter that he considered the advent of the San José Scale into the orchards of Ontario, although it had done an enormous amount of injury, had really been a blessing to fruit growers, because with the lime and sulphur wash if properly applied, they now knew they could control this insect and the work which had been necessary owing to its presence had placed their orchards in a far better condition than they would have been had the scale never invaded the province. Systematic spraying had become a necessity and with its practice many of the regular enemies of the orchard had disappeared. The general condition of these orchards, he believed, was now greatly improved. Many different materials have been experimented with as remedies but up to the present time nothing better than the lime-sulphur wash has been discovered and fruit growers will be wise to recognize this as the standard remedy for the treatment of their orchards and leave experimenting with new materials

to the professional entomologists who always try these newly suggested remedies, and, it may be added, have in the past found most of them of little value.

There is much inquiry every year for the regulations under which the government permits nursery stock to be imported into Canada and also with regard to the formula used for destroying the scale on trees which are imported. In the first place it may be stated that the sole purpose of the government federal fumigation houses is for the cleansing of the stock from the San José Scale, and there is no legislation whatever of the same nature against any other insects. This statement is called for by persistent misrepresentations which are made in British Columbia. In that province the government officials condemn and frequently destroy nursery stock upon which they find several other insects besides the San José Scale; but the only one against which at the present time any federal legislation has been enacted is the San José Scale.

The formula used.—The formula used at the federal fumigating stations is one ounce of cyanide of potassium (98 per cent), one ounce of commercial sulphuric acid (66° Baumé), and three ounces of water, for every 100 cubic feet of space, and all nursery stock is exposed to the gas generated by this mixture for 45 minutes. This formula generates sufficient hydrocyanic acid gas of a strength requisite to kill every scale insect upon the trees in the 45 minutes during which stock is exposed to it.

Fumigating Stations.—There are six points only along the border at which nursery stock can be imported into Canada. At those points the federal government maintains houses for the fumigation of all nursery stock coming into the country from other countries known to be infested by the San José Scale. These are as follows: Vancouver, B.C.; Winnipeg, Man.; Windsor, Ont.; Niagara Falls, Ont.; St. John's, Que.; St. John, N.B.

The federal fumigation houses are kept open, with a superintendent constantly in attendance, throughout the spring and autumn shipments of stock. The superintendents are all trained men, expert in examining stock, and in unpacking and repacking all packages which come into their hands. Up till the present time the superintendents at all of the stations have done their work carefully and well, and no well founded complaints as to carelessness or injury to stock have been received from importers, either with regard to the reasonable delay which must occur while stock is being treated or as to injury to trees during the necessary unpacking, handling and repacking. In every instance when complaints have been made a thorough investigation has been promptly instituted, and in every instance it has been satisfactory to report to the Honourable the Minister of Agriculture that any injury that trees suffered in transit could not be attributed to carelessness on the part of the superintendents.

The Customs regulations as now consolidated under the San José Scale Act read as follows:—

1. Under 'The San José Scale Act' the importation into Canada of any trees, shrubs, plants, vines, grafts, cuttings or buds, commonly called nursery stock, from any place to which the Act applies is prohibited, and 'any nursery stock so imported shall be forfeited to the Crown and may be destroyed, and any person importing nursery stock from any such country or place, or causing or permitting it to be so imported, shall be deemed to be guilty of an offence under section 6 of the Customs Tariff, 1897, and shall be liable to a penalty prescribed by that section.'

2. By an order in council approved March 18, 1898, the said Act prohibiting the importation of nursery stock is declared to apply to nursery stock from the following countries, viz.: United States of America, Australia, Japan, Hawaiian Islands.

3. By an order in council approved March 18, 1898, plants exempted from the operations of the above mentioned Act are as follows:—

(*a*) Greenhouse plants with the exception of roses (such as palms, ferns, orchids, cacti, chrysanthemums, azaleas, begonias and carnations, but not roses or any other woody plants).

(*b*) Herbaceous perennials (the tops of which die down in winter, such as perennial phlox, dielytra, peonies, perennial sunflowers, &c., and also strawberries).

(*c*) Herbaceous bedding plants (such as geraniums, coleuses, verbenas, pansies, &c.).

(*d*) All conifers.

(*e*) Bulbs and tubers (such as lilies, hyacinths, narcissi, and all other true bulbs, gladioli, caladium, irises, cannas, dahlias, &c.).

4. By an order in council approved April 25, 1900, permission is given for the importation of roses in leaf and in a growing condition which have been propagated under glass.

5. By an order in council approved January 5, 1901, nursery stock may be imported if fumigated at the following customs ports during the periods undermentioned, viz.:—

Winnipeg, Man., and St. John, N.B.—From March 15 to May 15 in spring, and October 7 to December 7 in autumn.

St. John's, Que., Niagara Falls, Ont., and Windsor, Ont.—From March 15 to May 15 in spring, and from September 26 to December 7 in autumn.

Vancouver, B.C.—From October 1 to May 1 of the following year.

Note specially, that,—(*k*) 'All shipments made in accordance with the above will be entirely at the risk of the shippers or consignees, the government assuming no risk whatever.

(*l*) Packages must be addressed so as to enter Canada at one of the above named ports of entry, and the route by which they will be shipped must be clearly stated on each package. The nursery stock will, however, be fumigated when transported via other ports to a fumigating station.

(*m*) Nursery stock imported by railway or vessel may be fumigated in bond while in transit, and after fumigation may be forwarded under customs manifests to a customs port of destination--the customs officer in such case to mark plainly on the manifests the word 'fumigated.'

(*n*) Collectors of customs at ports of fumigation are requested to co-operate with the railways and officials of the Agricultural Department in securing speedy fumigation of nursery stock in transit, and also to use their best endeavours to expedite the transit of such nursery stock.

6. By orders in council of March 23, 1901, and May 31, 1901, Dakota cottonwood, or 'Necklace poplar' (*Populus monolifera*, Ait.), may be admitted at the custom ports of Brandon and Winnipeg, Man., without fumigation.

IMPORTATIONS BY MAIL.

7. Nursery stock imported through the mails (by postal package or otherwise) is subject to the provisions of the San José Scale Act, and during the period allowed for fumigation customs officers are to send such nursery stock, after customs duty has been paid thereon, to the collector of customs at the nearest fumigation station, marked 'In bond for fumigation,' with post card advising that the parcel be fumigated and then returned by mail direct to the importer (giving his address) marked 'Duty paid.'

8. *Seizures.*—Customs officers are requested to strictly enforce the provisions of the law prohibiting the importation of nursery stock, and to seize all trees, shrubs, plants, vines, grafts, cuttings or buds, commonly called nursery stock, when imported from the countries above mentioned, in contravention of the aforesaid Act.

(Sgd.) JOHN McDOUGALD,
Commissioner.

Dipping of Nursery Stock.—The only safe remedy yet discovered, for the treatment of nursery stock for the destruction of San José Scale when nursery stock is being shipped from place to place, is fumigation with hydrocyanic acid gas. Many experiments have been tried with various washes for dipping nursery stock to obviate the expense and inconvenience of this operation but none of these have proved satisfactory, nor as good, all things considered, as the method of fumigation which has been adopted by this department. Experiments, however, are being constantly tried and if anything better is discovered it will be at once adopted. Nurserymen and fruit growers now know that no injury whatever is caused by the fumigation and it is now seldom advanced by shippers as was the case a few years ago as an excuse for bad packing and poor stock.

The San José Scale Act has now been in force for ten years having been passed on the 18th March, 1898. Since the fumigating houses were established in 1900 constant examination has been made of nursery stock which passed through the fumigating houses and on no occasion has a living scale been detected upon trees which have been treated by our superintendents. Many thousands of fruit trees and ornamental shrubs worth large sums of money have been imported by nurserymen and others in all parts of Canada, and although the scale can be killed with certainty, by fumigation in the way it is done in the federal fumigating houses, no injury whatever has been done to the stock by the treatment which it has received to free it from any possible presence of living scales.

In view of the above it may be justly claimed that the Honourable the Minister of Agriculture has taken every wise step to protect the fruit growers of Canada against a further introduction of this most serious enemy, and at the same time has done everything which was reasonably possible to protect the interests of nurserymen and others who wished to import stock from outside the Dominion. The methods adopted for the fumigation of stock are those which are most highly approved by experts and have been found perfectly effective in destroying any scales which occurred on nursery stock which was treated. The governments of Ontario and British Columbia have also adopted drastic measures to prevent the spread of the San José Scale from known points of infestation to new localities. At the present time after eleven years from its first appearance it may be said that the only place in Ontario where the scale now exists is the comparatively small area running from Essex county along the north of Lake Erie and extending to the county of Wentworth, west of Lake Ontario. In British Columbia the scale has been detected at two places, Kaslo and Spence's Bridge, but at the former of these the trees were carefully sprayed and since that time no further infestation has been detected. At Spence's Bridge the whole orchard was cut down. The San José Scale has never been found in the maritime provinces, the prairie provinces, the province of Quebec, nor in any other part of Ontario than that mentioned. As this insect seems to be able to thrive in all districts where the peach can be grown commercially it is most advisable that fruit growers in such districts should be on the alert to detect any strange scale insects upon their trees and have them examined by experts as soon as possible. Prompt attention at the beginning of an outbreak will frequently save great destruction of trees and crops and the expenditure of much money.

THE ROSE CHAFER, *Macrodactylus subspinosus,* Fab.—Injuries to grapes, peaches and apples by the Rose Chafer are of yearly occurrence in the Niagara districts of Ontario, but during 1907 their depredations were so serious that in many vineyards the whole crop was destroyed and the large wine-making firm of Bright & Shirriff, who buy between two and three hundred tons of grapes in the immediate neighbourhood of their establishment at Niagara Falls South, could not last year buy locally nearly all the grapes they required and had to import them from other districts. Mr T. R. Stokes, secretary of the Board of Trade of Stamford township, and of Niagara Falls South, in writing on this subject, says:—

'Last year the Rose Bug destroyed grapes to the extent of $60,000 in Stamford alone, immense graperies of ten and fifteen acres not producing more than a ton or a ton and a half. More than this they ruined shrubs and flowers in the historic cemetery at Lundy's Lane and the flowers in the beautiful Fairview cemetery have been much injured. They destroy the petals, pistils and stamens of the flowers of the grape. They make their appearance at the same time as the first grape blossoms. They also riddle the leaves of strawberries, raspberries and many other plants. The beetles only last for about a month, but they do an immense amount of harm. They appear suddenly simply in billions, destroying all flowering plants. In 1907 they appeared a week before grapes bloomed. They ate off the cap of the bloom and tore open the blossom and ate out the centre. They also ate the leaves to a certain extent, but the great injury is to the flowers. These Rose Bugs also tear up and destroy entirely the flowers of any scented roses they can get at. They do not touch the unscented varieties such as the Prairie King and the Crimson Rambler. They destroy a large percentage of the raspberry crop by destroying the blooms. This is a very serious matter and I trust that you will be able to come and map out some line of action for fighting this pest.'

There is no doubt that the Rose Chafer is a very serious enemy of the fruit grower wherever it occurs, and sometimes, as last year in the Niagara Falls district, it does an enormous amount of harm by attacking the flowers and young fruits of grapes, peaches and apples. Unfortunately very little can be done to control it. It is known that it breeds in sandy land, and where this can be ploughed up either just before the insects emerge early in June or late in autumn, a certan amount of good can be done, but all efforts with a view to poisoning the beetles on the flowers have failed. Prof. F. M. Webster in 1899 reported to the Association of Economic Entomologists (Proc. 11th Annual Meeting, Bull. No. 20, U.S. Div. of Ent.), the first successful experiment in killing the beetles in a wholesale manner. He says, page 20: 'At last we have found out how to kill the Rose Chafer. In view of the fact that the digestive apparatus of this pest seems to be proof against the poisonous or caustic effects of most drugs, this seems an achievement. One-half pound of fish oil soap dissolved in a gallon of water and sprayed upon them will kill 95 per cent of the adults, the females being especially susceptible, if the suds is sprayed directly upon them Drenching their food plant does not seem to affect them in the least, even if one pound of soap is used to each gallon of water, so the question of protecting vineyards is yet unsolved. Rhubarb has been found to be a valuable bait plant, the bloom which appears about the time of that of the grape being especially attractive to the beetles, and while clustered on the blossoms they can be collected or sprayed with the fish oil soap mixture and killed. The stronger mixture mentioned above did not appear to affect the peach, while the weaker injures the leaves and young fruit of the grape to some extent.'

The old fashioned remedy of hand picking is of course of service, but is slow and expensive even when as at Niagara Falls South there is an abundant supply of cheap labour. The children and women of the village are utilized in picking the beetles from the blossoms of grapes, but it is very easy for them to do much harm at that time by rough handling. The beetles may also be jarred on to sheets or frames saturated with kerosene, but these methods are tedious and must be practiced daily in the early morning or in the evening. Useful mechanical appliances on the plan of a funnel or inverted umbrella with a bag or can containing kerosene at the bottom for collecting the beetles when jarred from the plants are referred to by Dr. F. H. Chittenden in a circular on this insect (No. 11, 2nd series, U.S. Div. of Ent.).

In view of the success obtained by Prof. Webster in spraying with whale oil soap, experiments should be tried as to the strength which may be used without injury to the grape blossoms. The numbers of the beetles which have appeared for the last two or three years in the vicinity of Niagara Falls South are simply incredible. The occurrences were fortunately very local, some vineyards having every blossom stripped,

while in others hardly any bunches of fruit had been injured. Mr. Stokes attributes this freedom from injury to the time at which the blossoms opened. If the fruit is set before the beetles appear they do not seem to be specially attracted. It is while the flowers are open and the perfume is given forth that they are attracted and do so much harm. Clover when in bloom is also a favourite food plant for the Rose Chafer. Mr. Geo. Green, of Niagara Falls South, showed me a field of clover close to his vineyard which was simply a seething mass of beetles, which were swarming over the blossoms in hundreds of thousands. Mr. Green attributed a fairly good crop of fruit in his vineyard to the greater attraction which the clover had been for the beetles at the time the grapes were in bloom.

The Rose Chafer is a dull, yellowish grey beetle about one-third of an inch long, tapering a little towards each end. Its long sprawling legs are reddish with the feet black and tipped with strong claws with which it hangs tightly to the flowers it is destroying. The eggs are laid beneath the surface of the ground by the females, which burrow down about two inches at the time they lay their eggs. Each female lays about thirty eggs which hatch in three weeks, and the young grubs feed on the roots of grasses and other plants within their reach. They become full grown in autumn and pass the winter in a cell deep beneath the surface. At the opening of spring the larvæ come up near the surface in the month of May and change to pupæ in small oval cells. In shape the larvæ and pupæ resemble those of the well known White Grub.

Dr. Chittenden points out the advantage of prompt action in the collecting of the beetles or destroying them with contact sprays, immediately on their first appearance, and advises that all land which might serve as a breeding place should be ploughed and harrowed in May for the destruction of the pupæ. The least amount possible of light sandy land should be left in sod.

There are many brands of whale oil soap in the market. Those which are made with potash are considered the best and most convenient to use for the destruction of insects. That used by Prof. Webster was made by W. H. Owen, of Port Clinton, Ohio, and costs about 4½ cents a pound by the 100-pound keg.

THE BROWN-TAIL MOTH, *Euproctis chrysorrhœa,* L.—There has been considerable correspondence again during the past season with regard to the infestation of the Nova Scotian orchards by the Brown-tail Moth. The matter has been taken up energetically by Prof. Cumming, Secretary of Agriculture for Nova Scotia, who made use of the school children in the public schools in an effort to destroy all of the winter colonies of the caterpillars. A bounty of ten cents per nest was paid and these were sent in and identified by stated qualified officials and about 3,500 nests were passed as being those of the caterpillars of the Brown-tail Moth. Most of these were collected in a small isolated area near Bear River, N.S., where little work had been done the previous year. In those districts where operations were carried on last year, although a very much larger area was covered, not more than 200 nests were found. Prof. Cumming and Profs. Smith and Shaw, of the Agricultural College staff at Truro, N.S., have also been studying the matter carefully during the summer and arrangements were made for qualified men to go through the infested areas right up to the end of the season. Prof. Shaw thinks that the orchards of King's county, one of the infested districts, are absolutely clear of the pest and he does not know of any having been found in the forests adjacent. In Digby county also only four Brown-tail Moth nests had been found up till December 6 last, by five inspectors who the previous spring had found the nests exceedingly numerous in the same county. At the end of the winter season Prof. Shaw writes:—

'There have been about 15,000 specimens of insects sent in to Principal Cumming by the school children who have been collecting the Brown-tail Moth winter nests. Of these, 3,500 were of the Brown-tail Moth and these were found chiefly at Bear River and Smith's Cove, Digby county.'

The above reports are very satisfactory and the fruit growers of Nova Scotia are to be congratulated on the energy which has been shown by the above officials who have recognized the importance of this infestation and have acted promptly and energetically. It must be remembered, however, that the insect had become widely spread through the orchards of the province, that many of these are thickly planted and closely surrounded by forests or strips of wild native trees, and that this is a very difficult insect to control. It is almost too much to hope that the Brown-tail Moth can have been exterminated even by the energetic efforts which have been directed against it and every fruit grower in the provinces of Nova Scotia and New Brunswick should promptly send either to Prof. Cumming at Truro, or to this Division, specimens of any strange caterpillars they may find on their trees and particularly when these are occurring in large numbers during the summer, or gathered together in nests composed of leaves spun together with silk during the winter months. The only kind of caterpillar which is likely to be found in colonies inside such nests, is that of the Brown-tail Moth. These pass the winter as small caterpillars, only one-quarter of an inch in length and there are from 200 to 300 inside each nest. The caterpillars themselves are black, but are covered with rusty hairs but they can be at once recognized by two conspicuous orange cushion-like tubercles on the top of the 10th and 11th segments towards the end of the body.

Remedies.—The remedies for this dangerous enemy are the collection of the winter nests of the caterpillars and the systematic spraying of all orchards during the summer. For this purpose the poisoned Bordeaux mixture is the best remedy and will control at the same time the Brown-tail Moth and all other leaf eating caterpillars, and will reduce better than any other known remedy, the fungous disease known as the Black Spot of the Apple and Pear, which frequently does great injury to the important apple crop of the Maritime Provinces. As the Cankerworm is a frequent and destructive pest in Nova Scotian orchards, one spraying should always be done within two or three days after the apple blossoms fall. At that time the Cankerworm can be more easily destroyed than at any other time, but if it is left unmolested until half grown it is extremely resistant to the effects of arsenical poisoning. As poisons for the above purpose, arsenate of lead and Paris green are probably the best. Of the arsenate of lead there are several brands in the market and the material can also be made at home, but for convenience and effectiveness probably the manufactured article is the most satisfactory, because it is not only put up in very convenient packages but the chemicals with which arsenate of lead is made, are sometimes variable in quality, whereas in the large factories these materials are tested carefully to see if they are up to standard. When using Paris green in Bordeaux mixture, one pound may be used in 100 gallons of the Bordeaux mixture. This is stronger than is actually required, but the lime in Bordeaux mixture will neutralize the caustic effects of the arsenate and the Brown-tail Moth is a very serious pest which must be dealt with, with drastic measures, and the same may be said of the Cankerworm. Arsenate of lead should be used at the rate of three pounds of the paste to a 40-gallon cask of Bordeaux mixture. It may be well to warn fruit growers against using arsenites in what is known as the soda-Bordeaux mixture, more properly called Burgundy mixture. The true Bordeaux mixture is made with lime and for all ordinary purposes on fruit trees the amount recommended is 4 lbs. of bluestone, 4 lbs. of unslacked lime, 4 ounces of Paris green and 40 gallons of water, but for certain pests more Paris green is advisable and by increasing the amount of lime a little it becomes a safe application for orchard trees while the leaves are young and vigorous, but the arsenites should always be applied in the real Bordeaux mixture made with lime and not with the soda-Bordeaux.

In the report of the Chemist of the Experimental Farms for 1905, at page 149, will be found an article on the Chemistry of Insecticides and Fungicides. In the conclusions of Mr. Shutt's experiments the matter is summed up as follows: 'Burgundy mixture pure and simple has shown itself as far as our experiments have gone, to be

non-injurious to foliage. The addition of Paris green or other arsenite, however, renders the spray corrosive and therefore dangerous for orchard use. When it is desired to use Paris green as an insecticide in the spray, only Bordeaux mixture made with lime should be employed.'

Cankerworms.—Reports of rather serious nature came to hand with regard to the injuries of cankerworms in the apple orchards of the Annapolis Valley of Nova Scotia. These caterpillars are very slender and inconspicuous at first and are frequently overlooked until they have attained considerable growth. They are then much more difficult to kill with the ordinary insecticides used in orchards and it becomes necessary to use more poison to the barrel than for most other insects. It is recommended to use as much as one pound of Paris green in 100 gallons of Bordeaux mixture and this latter should be made with five pounds of lime to the four pounds of copper sulphate in the 40 gallons of water. If applied while the caterpillars are young the cankerworm can be controlled the same as every other leaf-eating insect. The other remedy for cankerworms is the destruction of the wingless female moths when they leave their chrysalids in the autumn and climb up the trees to lay their eggs. There are two materials which are largely used for this purpose. These are printers' ink thinned with fish oil, one gallon of the latter to five of the former, which quantity will treat about an acre of orchard, and the other is a mixture of castor oil and resin. Mr. O. T. Springer, of Burlington, Ontario, gives the following receipt:—

For cold weather; castor oil 2 pounds, common resin 3 pounds; for warm weather add another pound of resin. This mixture must be heated slowly until all the resin is melted, and then should be painted directly on to the bark of the trees while still warm.

Mr. Geo. E. Fisher, of Freeman, Ont., after many experiments uses the same materials but prepares them rather differently. He writes: 'For use against cankerworms, I use for warm weather, 3 pounds of castor oil and 5 pounds of resin, and in cold weather equal parts of both by weight. A little experience is necessary to decide just what proportions of the materials will suit the prevailing weather conditions, but they will vary between the weights I have given. The rough bark of the tree should be scraped off at a convenient height before applying the mixture. The first application will not remain sticky very long, being apparently absorbed by the bark, and a second may be necessary in about a week. This will keep fresh for a good while, and certainly is an excellent trap for cankerworms either in the moth or caterpillar stage.' When applying these mixtures they are painted directly on to the bark of the tree with a large paint brush so as to form a band right around the trunk about three inches wide. The castor oil used is a commercial article, unpurified, which will cost in most places about 8 or 10 cents a pound. Mr. Springer says that the work of banding in the above mentioned way is not so great as might be supposed. One man can go over 250 trees in ten hours if the mixture is ready for use. Should the mixture get too cold to spread readily it may be easily and quickly brought to the proper temperature by using a portable oil stove. It is best to put on the first coat plentifully so as to leave a good body of material on the tree. In the Burlington district, which is near Hamilton, Ont., the female moth seldom leaves the ground before the last week in October and never before the first frosts of autumn. If watched for and the bands are painted on to the trees when the females first appear, thousands are caught by the band, including many of the males, which also are destroyed, their delicate wings adhering to the sticky material on the slightest touch. The females, unable to cross the sticky bands, lay their eggs in large numbers on the trunks of the trees between the ground and the band. These must be scraped off and destroyed during the winter or the caterpillars will climb up into the foliage when they hatch in the following spring, for by that time the bands will have dried on the surface or will have become rough by rubbish or dust adhering to them.

The Rusty Tussock Moth, *Notolophus antiqua*, L.—The work which has been done in Nova Scotia in collecting the larvæ of the Brown-tail Moth has shown that

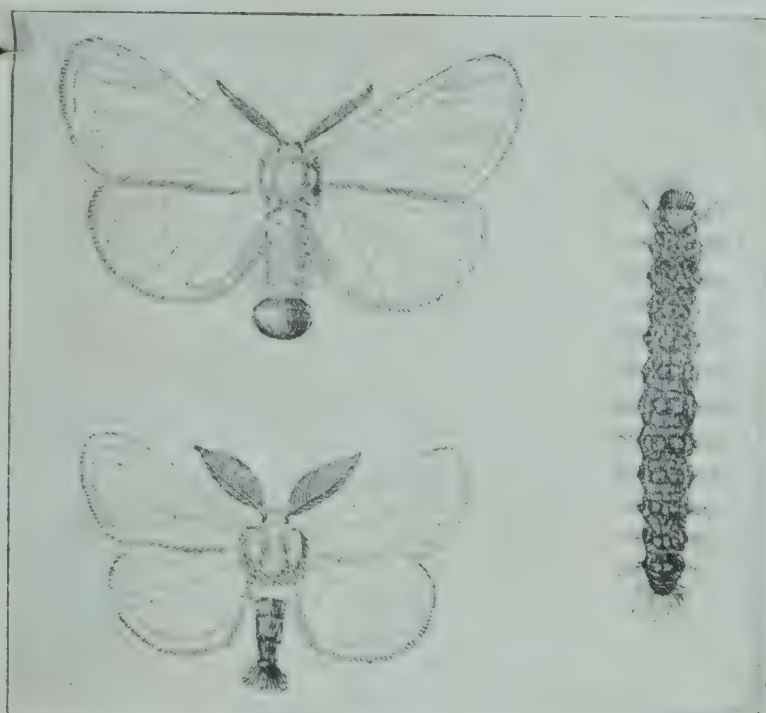
considerable injury is done every year to apple and other fruit trees by the Rusty Tussock Moth, not only in eating the leaves of the trees but by gnawing cavities in the sides of the growing apples. Both the Rusty Tussock Moth and the White-marked Tussock Moth occur in Nova Scotia, and the work of both is very similar, but the latter is the more serious pest of the two because it generally occurs in large colonies and not in the scattered way that the former does. The two insects are quite different and easily recognized in all their stages. The caterpillar of the Rusty Tussock Moth is a much less showy insect than its near relative. The general appearance of the body is gray with four short thick tufts of whitish hairs on segments 5, 6, 7 and 8 with red spots along the sides and a yellow line beneath the spiracles. The most conspicuous difference is that the head is black instead of coral red as in the caterpillar of the White-marked Tussock Moth and there is an extra pair of long tufts of barbed bristles on each side of the 6th segment (counting the head as the 1st), which are entirely lacking in the allied species. The yellow stripes down the back so conspicuous in the White-marked Tussock Moth caterpillar are almost obliterated in that of the Rusty Tussock Moth. The food habits of the Rusty Tussock Moth are very much less restricted than those of the White-marked species, which is almost confined to the foliage of trees, while the caterpillars of the Rusty Tussock Moth may be found upon almost any kind of tree, shrub or herbaceous plant. They seem to be particularly partial to the foliage of geraniums and some other garden flowers. The moths are also different. In the Rusty Tussock Moth the male is of a rust-brown colour, the front wings crossed by two wavy streaks and there is a conspicuous white crescent near the hind angle of each. The wings expand a little over an inch. The female is gray and practically wingless, in this respect resembling the female of the White-marked Tussock Moth. The male of the White-marked Tussock Moth is gray and the wings are crossed by wavy bands. The base of the front wings bears a dark patch and there is another of smaller size towards the tip. There is also a small white spot near the outer hind angle of the front wings. In both species the wingless females on emerging from their cocoons remain there at rest for their whole moth existence. The males seek them out and after pairing, the eggs are laid on or close to the cocoon. Those of the Rusty Tussock Moth are bare and easily distinguishable but in the White-marked Tussock Moth they are covered with a frothy white deposit so that their shape cannot be seen without breaking up the egg mass.

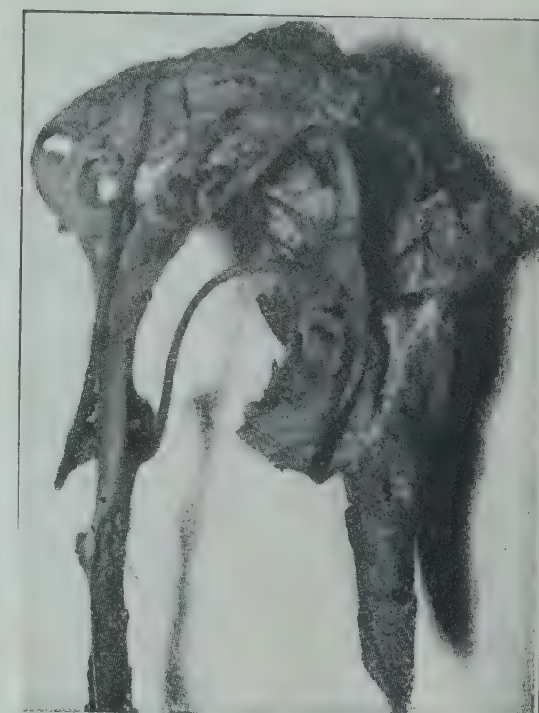
Both of these insects are sometimes the cause of considerable injury and neither should be allowed to increase with impunity. In many of our Canadian cities the beautiful shade trees are year after year rendered unsightly by these caterpillars and little is done to check them except an occasional spasmodic effort when they have become so bad that the municipal authorities are compelled to do something.

The remedies are the spraying of the trees as soon as possible after the young caterpillars have made their appearance, and the collection of the egg-masses during the winter.

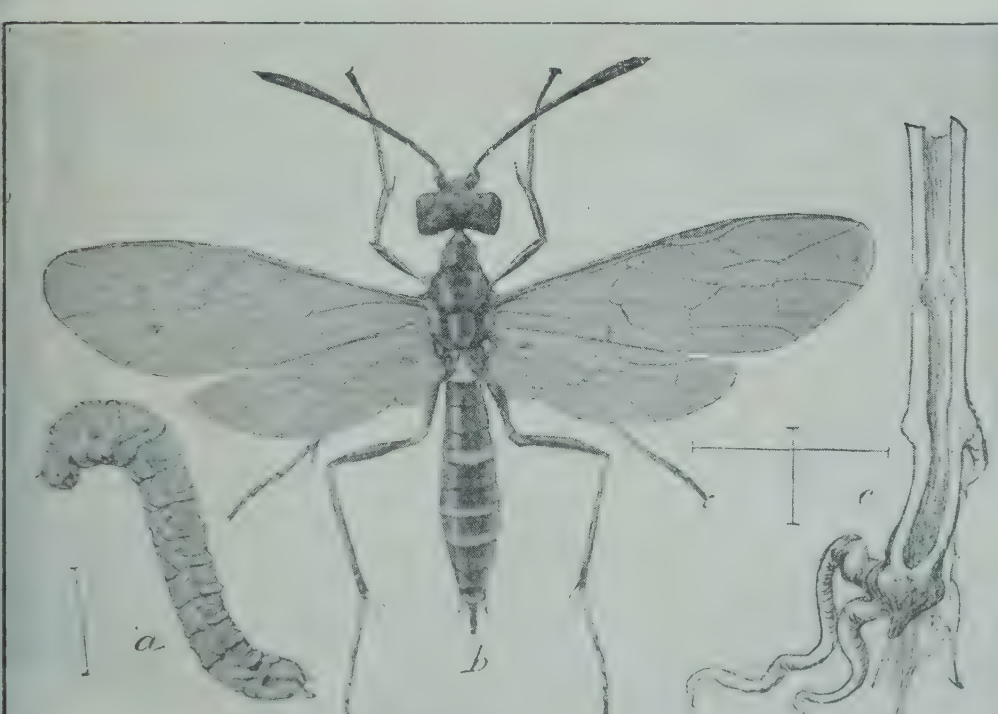
THE HICKORY TUSSOCK MOTH, *Halisidota caryæ,* Harr.—Throughout the whole of eastern Canada considerable damage was done to forest trees of several kinds, such as hickory, elm, birch, ash and basswood by the black and white hairy caterpillars of the Hickory Tussock Moth. These caterpillars occurred in unusual abundance in 1907. When young the caterpillars are very gregarious and frequently strip whole branches of a tree. They have a habit of collecting together in dense clusters beneath the leaves at night, but when feeding spreading out all over the tree making silken paths as they travel along the branches. This caterpillar is particularly objectionable as an orchard and shade tree pest because when falling on the bare skin the barbed hairs produce a painful and persistent irritation.

The caterpillar of the Hickory Tussock Moth when full grown is described as follows by Mr. Arthur Gibson in an article written for the report of the Entomological Society of Ontario for 1907, at page 84. 'The body is clothed with dense tufts of white hairs with a ridge of black hairs down the centre of the back, and two pairs of

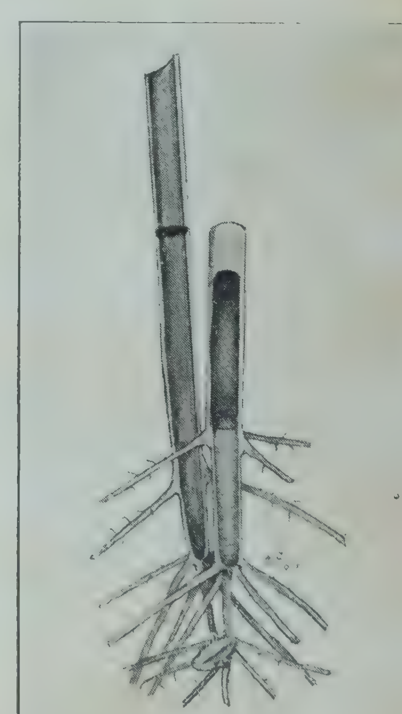




Female and male moths ; full-grown caterpillar. Winter nest. (After Kirkland.)
(Figures from Howard, U. S. Dept. of Agr. Farmers Bull. 264).
THE BROWN-TAIL MOTH ; *Euproctis chrysorrhœa*, L.



Western Wheat-stem Sawfly. (*Cephus occidentalis*, Riley & Marlatt.)
(Riley & Marlatt, Insect Life, IV, Div. Ent. U. S. Dept. Agr.)



Larva and work of the Western Wheat stem Saw-fly.
(Drawn by Norman Criddle.)

long black pencils on the 1st and 7th abdominal segments. When full-grown this caterpillar is one inch and a half in length.'

Occurring with the above and almost as abundant was the rather handsomer caterpillar of the Spotted Halisidota, *Halisidota maculata*, Harr., which is covered with tufts of bright yellow and black hairs, the black tufts being on the four anterior and the three posterior segments, the yellow tufts on the central segments of the body. These latter are centered down the middle of the back with a row of black tufts. This larva is rather shorter than that of the Hickory Tussock Moth and although a general feeder like the other seems to prefer willows and poplars to other food.

Large numbers of these caterpillars were sent in by correspondents who had been attracted by their appearance or who had suffered from the irritation of their bristles. In the autumn and early spring large numbers of the close oval cocoons beset with the bristles of the caterpillars were found beneath stones in woods and in other shelters near where the caterpillars had fed. Many of these were found to be parasitized by *Pimpla pedalis*, Cress.

As a rule neither of these insects develop into pests of importance, but upon occasion, as during 1907, their attacks upon shade trees are serious.

A sufficient remedy is spraying the trees when the caterpillars are noticed with Paris green or any other of the arsenical poisons. Both of these species are late summer and autumn insects and neither of them has so far proved a serious orchard pest.

THE APIARY.

The Apiary is under the management of Mr. D. D. Gray, the farm foreman, whose report I append herewith. The practical work of handling and caring for the bees has been done by Mr. C. A. Burnside. There was a considerable amount of disease in the colonies in the beginning of the year, but by the end of the season this had disappeared and such colonies as we had were in good condition. The inclement weather of early spring rendered the services of bees in fertilizing fruit conspicuously apparent. In orchards situated near apiaries there was a considerable increase in the fruit over those not so advantageously located. It having been decided to reduce the number of colonies in the apiary, some of those which were strong and healthy were sold and the number on our own stands was reduced to 32.

REPORT OF MR. D. D. GRAY.

SEASON OF 1907.

The spring of 1907 was very cold and backward.

The bees were placed on their summer stands on April 20, nearly all very badly affected with dysentery and very weak, in fact a number dwindled and died, although they had had plenty of stores through the winter.

The weather continued cold and windy well on into May and the first notice of pollen being gathered to any extent was on May 10. Some feeding was done to encourage brood-rearing and by June 15 quite a number were strong enough to have supers put on and by the first week in July all were ready for work. The first swarm came off on July 10 and we had six of an increase from the 32 colonies put out on the stands. There were a few colonies, however, which escaped with very little of the disease and these did well, one colony making 215 lbs. of honey.

The bees were put into their winter quarters on November 13 weighing an average of about 50 lbs. each.

All the colonies were raised from the bottom boards and blocked up 1 inch all around between brood chamber and bottom board to allow for better ventilation. The wooden covers were also removed and replaced by bran sacks, 2 or 3 being put on each colony.

The bees were examined from time to time and kept as nearly as possible at a temperature of 45° to 50°, and at time of writing, April 1, are seemingly in good condition and quiet, keeping well clustered up in the combs.

D. D. GRAY.

INSTRUCTIONS FOR SENDING INSECTS THROUGH THE MAIL.

A constant source of inconvenience and loss of time to the officials of the Division is the manner in which insects and plants are sent in for identification. It is most advisable that inquiries should always be accompanied by specimens and that these should be packed in such a way that they may come safely by mail without the parcels being crushed and destroyed, or in the case of living insects so that these should not escape. Experience has proved that it is a very difficult thing for those who do not make a study of natural history to write descriptions of either insects or plants so that they can be recognized without specimens. There is also a tendency everywhere to give new and local names to any enemy which has forced itself upon the notice of farmers, fruit growers and others, by its sudden appearance in unusual numbers or by its injuries to crops. These local names are as a rule not in the least descriptive of the pest and only in the very rarest instances are they in any way applicable to any striking characteristic of the insect or plant to which they are given. They are generally quite unintelligible to others and are a source of dire distress, annoyance and waste of time to the specialist who is referred to for information, unless specimens accompany the inquiry. It may certainly be accepted as a general principle that any insect or weed which occurs in sufficient numbers to be troublesome is not of a new kind which requires re-naming. There are now several sources of reference in Canada, where every one who wishes to do so can find out with very little trouble the nature and habits of any unwelcome visitor which may appear in farm or garden. All that is necessary is to send a specimen to one of the many government institutions or agricultural papers with a few lines descriptive of the occurrence and a statement of what information is desired. When such inquiries are made the following rules may be followed and are merely mentioned here, surprising as it may seem, because they are so frequently neglected by correspondents of this Division.

1. Sign the letter of inquiry and give post office address in full, stating province and post office to which a reply should be sent.
2. Send specimens representative of the species. In the case of plants, if possible, send flower, leaf and root. As everything comes free by mail to the Experimental Farm, Ottawa, and the postmasters in all parts of Canada have printed instructions to this effect (Canada official Postal Guide, 1908, p. xxiv), there is no advantage to any one, and a great disadvantage when accurate information is desired, in sending small chips instead of proper specimens.
3. In all cases write the name of sender with his address on the packet.
4. Do not inclose letters inside packets of specimens but send them separately.
5. Do not send specimens without a letter or note saying what information is desired.
6. Do not send fragile specimens in paper boxes. The post office officials have sometimes to handle several tons' weight of mail, and fragile packets are easily broken under such circumstances.
7. Do not send specimens in glass bottles or in liquid unless carefully protected.
8. When sending specimens or writing for information let the letter and the specimens if possible go by the same mail.
9. Living specimens of insects or plants should always if possible be sent in tin boxes. Insects should always be accompanied by some of the food plant for them to feed upon during the journey. Tin boxes prevent the evaporation of moisture and

keep the food plants fresh. For this reason as well as for the greatest safety of the specimens they are very much preferable to cardboard boxes.

10. When sending specimens do not punch holes through the box for the insects to breathe through. These are quite unnecessary and as a general thing cause the death of the specimens.

It will be easily understood how very inconvenient it is in an office with a limited staff, but with a very large daily correspondence, when, as frequently happens, four or five packets of insects or plants arrive by the same mail without any name on them of the sender and without any letter stating what information is desired. Parcels when sent through the post offices are very seldom postmarked and all that can be done is to hold them over for some days and then compare the writing of the address with letters which have been received during the past week. This means, frequently, in the case of specimens of important pests which we want to know about or concerning which an immediate reply should be given, looking through about one hundred letters. The inconvenience of caring for these parcels is also considerable. Living specimens have to be unpacked and fed and provisional numbers and labels put on each, so that they may be recognized in case letters turn up afterwards. Notwithstanding every care to keep these parcels straightened out there are every year many which come to hand which can never be acknowledged, either because the parcels have nothing on them by which we can associate them with letters or because the letters are not signed.

In addition to specimens which are sent in by farmers, fruit-growers and gardeners, many insects and plants are sent in for identification by those who are studying natural history in a more or less scientific manner. An excellent sign for getting better results in farming, is that, many of the younger farmers and fruit-growers in the country are now making reference collections of injurious insects and weeds, so that they may become more familiar with these enemies from which they every year suffer so much. These collections are continually being received for identification and classification by the officers of the Division of Entomology and Botany. Similar collections are sent in by teachers and other students.

The study of entomology in Canada is now receiving a good deal more attention than heretofore. Each season sees new collectors in the field and much of the material collected is sent to Ottawa for identification. Unfortunately, however, many of these specimens received here are more or less injured from lack of knowledge as to the proper way to pack, or of care in doing up the parcels. It is a constant matter of surprise to see how few of even experienced entomologists, know how to pack specimens for sending by mail. A frequent disappointment experienced at the Division is to find on opening a box, valuable specimens which have been entirely ruined through the neglect of some small or commonsense precaution in sending the specimens. Mail matter received at large centres must of necessity be handled quickly and a moment's thought will convince any one that a box containing specimens of fragile pinned insects, wrapped only in the paper on which the address is written, has very little chance of reaching its destination with the contents intact. Many such consignments come to us with nearly every specimen broken.

There are several good ways of packing boxes of pinned specimens. The box containing the insects firmly pinned, the pins being forced into the cork at the bottom with a pair of forceps, can be wrapped lightly with cotton batting, or some other light elastic material, and the whole placed inside a larger box of wood or strong cardboard. The inside box should be wrapped neatly in thin paper and tied up to keep out dust. The elastic packing between the two boxes will protect the specimens from being broken by the jarring in the mails. Another excellent way which may be used when it is not convenient to obtain an outside box of the right size, and indeed is the method most in use by entomologists, is to simply surround the box of specimens after wrapping it in paper, with a good supply of cotton batting, hay, straw, excelsior or

other light material of an elastic nature, and then wrap this in good strong paper. The address of the person to whom the specimens are sent should always be written on a separate label which should be tied to the parcel so that this may receive the postmark instead of the parcel, should the postmaster stamp it while passing through the mail. It may be remembered that it is always better to put too much packing than too little and when the box containing the specimens is protected by an outside box there should be plenty of space between the two. An ordinary shallow cigar box corked at the bottom answers very well to pin insects in. Cork is by far the best material to use for this purpose but corrugated paper, pith, sheets of peat, or any other soft penetrable material may be used if of sufficient depth to support the pin securely.

Packages packed as above will come safely through the mails and may, as in the case of letters, be sent to the Division of Entomology at the Central Experimental Farm, free of all postage. If for any reason it is desirable to send specimens by express, this can be done by placing the box of insects in an ordinary fruit basket, surrounding it well with light packing, such as is mentioned above, and covering the top with ordinary wrapping paper. When sent by express, charges on the parcel must be prepaid by the sender.

A convenient way of sending specimens for identification, particularly when these are winged insects, such as butterflies and moths, is to put each specimen in a small envelope as soon as it is killed, with the wings folded backwards over the back. This should be done before they become too dry and brittle, or the legs and antennæ will be broken, which very much reduces their value as scientific specimens.

The killing bottle used for insects is easily made. Having procured a wide-mouthed bottle, place in the bottom of it two or three small pieces of cyanide of potassium, each of about the size of a hazel nut, and then mix some fresh plaster of Paris into a thick paste and pour enough of it into the bottle to entirely cover up the poison. The plaster will set in about half an hour and the bottle is then ready for use. This bottle will last for a year or two if kept closely corked. The fumes given off will pass through the plaster and will kill any insect put in the bottle in a few minutes. When insects are packed in the envelopes these should at once have written on them the date and exact locality of capture, as well as the name or initials of the collector. They should then be packed away in a firm box and should not be moved again until such time as they are to be relaxed for examination or mounting for the cabinet. To relax specimens all that is necessary is to soak a cloth in water and then after wringing out the superfluous water by twisting it tightly, place the envelopes between the folds without opening them and leave them there for 12 to 24 hours according to the size of the insect. They will then be soft enough to be set on the setting boards. When set they should be left on the boards for at least a week, so as to become thoroughly dry or the wings will not remain even, after they are put in the cabinet. This 'springing back' of the wings spoils the appearance of the specimens in the collection. The envelopes used by entomologists are not gummed but are made as required. A convenient size can be made by taking oblongs of any moderately stiff paper, 4 inches long by 3 wide, and folding them diagonally down the middle so that the portion folded down reaches to within half an inch of the end of the opposite side, the half-inch flap is then folded down over the central triangular double folded portion and the envelope is turned over and the flap on the other side is treated in a similar way. This gives a triangular envelope which can be opened by taking the flaps on each side with the finger and thumb of each hand, and the specimen can be examined without danger of breaking it. This cannot be done easily with an envelope made in the usual way. The envelopes can of course be made of any size to fit the specimens to be saved.

When plants are sent as botanical specimens to be named, they should first be dried in the usual manner between sheets of absorbent paper and each specimen should be placed on a separate piece of newspaper, cut to a convenient size for mailing. With each specimen or written on the sheet of packing paper, should be a note of the date

and locality where it was collected. Unmounted specimens are preferable for examination to those mounted or fastened down to sheets of mounting paper. Botanical specimens should never be fastened down in bound books and there should never be more than one kind of plant on each sheet. A bundle of dried plants can be sent safely by mail if protected on the outside with sheets of cardboard.

When plants are sent in as weeds or merely to get the names of a few specimens, all that is necessary is to roll up each one separately in a piece of paper and number the specimens in accordance with notes on each given in the accompanying letter of inquiry. If it is desired to have the specimens returned this should always be stated and as with specimens of insects every packet of plants should have the name of the sender written plainly on the outside and be accompanied by a letter enclosed in a separate envelope.

Under the above conditions it is always a great pleasure to examine and report upon any specimens which may be sent in, and all will be attended to and the report sent back as promptly as other work in the Division will allow of, but when several plants are tied up in a bundle or crowded into an envelope, as is sometimes done by our correspondents, frequently in a moist condition, much time is wasted in doing here what the enquirers ought to have done before sending in the specimens. Moreover when they get their plants back again they are of far less value to them for purposes of identification than if they had dried them and packed them with a little care at first.

When correspondents wish it, we are always pleased to return the specimens sent in for naming; but when they have duplicates in good condition we are glad to get them either for our own collections in the Division or for other correspondents who frequently ask for specimens of special plants or insects. Very many species of natural history objects although very common in certain localities, do not occur at all or are quite rare at other places.

AUTHOR'S EDITION

FROM ANNUAL REPORT ON EXPERIMENTAL FARMS FOR THE YEAR 1911-12

CANADA

DEPARTMENT OF AGRICULTURE

CENTRAL EXPERIMENTAL FARM

REPORT OF THE DOMINION BOTANIST

H. T. GÜSSOW.

FOR THE

YEAR ENDING MARCH 31

1912

OTTAWA
GOVERNMENT PRINTING BUREAU
1912

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REPORT OF THE DOMINION BOTANIST

H. T. GÜSSOW.

OTTAWA, March 31, 1912

J. H. GRISDALE, Esq., B. Agr.,
Director, Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to submit herewith the third report of the Division of Botany, which is an account of some of the work carried on during the year from April 1st, 1911, to March 31st, 1912.

The number of enquiries received from farmers throughout the Dominion has considerably increased, so that very little time remained to carry on original researches into many important problems. Progress is, however, being made in some directions, as far as time and opportunity permit, but it is felt that the daily routine and executive work connected with the large correspondence and number of inquiries restrict more important and necessary investigations, which it is my opinion should receive the main attention of the staff of the Division.

There exists practically in every province certain pressing needs which come within the scope of work of this Division, and which should be attentively investigated to prevent the spreading of diseases or weeds, as the case may be.

Although it would be difficult to outline the work of each individual member of the staff during the year, it will be apparent that we were all working under high pressure since over 300 cases of disease were studied and nearly 1,000 plants identified, described and reported upon.

The systematic work i.e. the collecting and classifying of fungi and higher plants made very satisfactory progress. In the Botanic Gardens considerable new work was begun concerning the representation of the district flora and the collecting of seeds of trees, shrubs and other plants for exchange with other botanic gardens and institutions. Much time was devoted to the correct labelling of many trees and shrubs, all labels having been specially prepared and written in large type during the winter months by my foreman, Mr. Franz Horn, whose skill and careful work in this and other connections is much appreciated.

There have been maintained a large number of experimental plots exhibiting fodder grasses and plants, a series of clover and alfalfa variety tests, and the plots of broom corn under the charge of Mr. B. Nothnagel, who through many years of experience has shown himself a careful and reliable observer. During the winter months the services of this officer are much in demand by other Divisions, as semi-official translator of letters written in at least six foreign (mainly Slavonic) languages.

The field experiments on diseases affecting fruit-trees, grain, potatoes and other kinds of vegetation have also been in charge of this officer under my personal direction.

The vacancy created by the resignation of Mr. Herbert Groh was filled by Miss Faith Fyles, B.A., who has charge of all the work connected with the Botanic Gardens.

Herbarium, identification and collection of plants and such experiments as come within the scope of systematic botany. Miss Fyles has also shown herself to be an expert artist, and her skill in this connection has been much in requisition and has been found very useful in all phases of work of this division.

The Chief Assistantship is held by Mr. J. W. Eastham, B.Sc., who devotes as much of his time as possible to experiments in connection with the cause and control of plant diseases. His experience and careful observation will no doubt lead him soon to valuable results in some of his work. He has also charge of the cryptogamic herbarium and collection. To all these officers, including Miss Fairbairn who is in charge of the correspondence, library and records, I express herewith my appreciation for the ready help upon which I could count at all times, and without which the work of the Division would have been slow in progress.

I have the honour to be, sir,

Your obedient servant,

H. T. GÜSSOW,

Dominion Botanist.

Helminthosporium disease of Barley. *a.* Attacked ear remaining in leaf sheath. *b.* Spotted leaves. *c.* Spotted grains. *d.* Portions of aborted ear. *e.* Small, shrivelled grain, result of an attack.

PLANT PATHOLOGY.

THE EFFECT UPON VEGETATION OF WATER TREATED WITH HYPOCHLORITE OF LIME AGAINST TYPHOID FEVER.

During typhoid epidemics the water supply of cities is temporarily treated with Hypochlorite of Lime in order to destroy the active typhoid bacilli in the water and thus prevent the spreading of this disease by means of impure water.

Coincidentally with this practice, nurserymen and others using this treated water for their greenhouse and other plants, stated that they noticed a peculiar failing in the vigour of their plants, and thus were anxious to obtain advice whether this water may be injurious to plant life. Considering the great germicidal properties of this preparation, it was thought probable that injury might also result to higher plants from its use.

For this purpose the Dominion Chemist, Mr. F. T. Shutt, M.A., and myself began a series of experiments in February, 1911, which were continued with a view of disclosing any facts bearing on the subject.

We obtained a number of plants which were suspected to be failing in health owing to their being treated with chlorinated water. Three plants of Carnations and three of Hybrid Roses of this kind were subjected to the following treatment:—

1. Potted into new soil, watered as required with snow water only.
2. Potted into new soil, watered as required with chlorinated water (0·26 p.p.m. available chlorine).
3. Potted into new soil, watered as required with chlorinated water, but boiled for fifteen minutes.
4. Potted into new soil, watered as required with chlorinated water plus 1 lb. of soot per 3 gallons of water.
5. Roses grown on the Farm used as check plants treated in the same manner with chlorinated water.

The plants were very carefully watched and kept under the same condition of temperature and culture. After three months had elapsed no difference whatever could be noticed in any of the plants. The roses blossomed freely throughout, the carnations, however, hardly recovered, having been transplanted while practically in flower. The check plants subjected to the different modes of treatment showed not the slightest signs of any injury.

Another experiment was conducted to test the effect of chlorinated water on the germination of seeds. Various strengths ranging from 0·05 to 10 parts per million of available chlorine were used. Six varieties of wheat were employed, the seed being soaked in the freshly made-up solutions, and an equal number in distilled water. (Time 12 hours.)

All samples were sown on the same day. Germination was found to be uniform throughout; no influence could be observed on the energy of germination or in the development of the young plants. Later on, a series of experiments was started with barley and oats without any sign of injury, or even retardation. The plants were grown until in flower, when the earth was washed away and the plants, root and all, were carefully dried in the air and then weighed. Although slight differences in weight between plants of the same series occurred, such did not indicate that there had been any injurious influence exerted by the chlorinated water.

Radishes, turnips, cucumbers and beans were also subjected to treatment in the same way. The cucumber plants treated with chlorinated water showed rather a more vigorous growth than those receiving snow water only. Geraniums behaved absolutely identically when treated with melted snow water and that containing Hypochlorite of Lime.

Without going into further details, Mr. Shutt and the writer, as a result of this investigation, conclude that the water supplies, as ordinarily treated with Hypochlorite of Lime have no injurious effect, direct or indirect, upon cultivated plants.

SOME DISEASES OF CEREALS.

(See Plate VI.)

Not uncommonly, there is found on the cultivated barley a disease known by the names of 'yellow leaf,' 'early blight' and 'leaf-stripe.' The last name is especially appropriate since the disease in its earlier stages takes the form of very conspicuous, elongated, yellowish-green spots, more or less sharply bounded by the veins of the leaf and frequently extending for the greater part of its length. Later, the spots turn brown, the attacked leaves die, and, owing to the loss of leaf tissue, the yield may be appreciably reduced. This disease is due to the fungus *Helminthosporium gramineum* Rabh., the spores of which may usually be found in abundance on the discoloured areas.

During the past season, there was observed on some of the barley plots at the Experimental Farm a disease due to a closely-related species of *Helminthosporium*. In this case, however, the leaf injury instead of appearing in the form of the stripe-like discolourations just described, shows as small, usually elongated spots, dark brown in colour, but often with a paler border. These spots are frequently so excessively abundant as to cause the total browning and shrivelling of the leaf. The disease is apparently much more severe on the leaves than that due to *H. gramineum* Rabh. and it also appears to affect the ears to a greater extent

Enquiry showed that the occurrence of a similar disease had been recorded in the State of Iowa, U.S.A., and described by Prof. Pammel et al. in Bulletin 116 of the Iowa Expt. Station. It was found to be due to a species of *Helminthosporium* considered by the authors to be one hitherto undescribed and provisionally named by them *H. sativum*.

Comparison of the symptoms of the disease as it occurred at Ottawa with the published description of the one observed and described by Prof. Pammel seemed to leave no doubt that the two were the same. For confirmation, however, specimens were sent to Prof. Pammel who pronounced the disease to be identical with the one described by him. Its occurrence at Ottawa is, therefore, of sufficient interest to be worthy of record apart from the possibility of its becoming a serious pest of the barley crop.

Control.—Both the diseases just mentioned are carried over from year to year by infected seed. Since, however, the fungus is actually within the grain as mycelium and not merely adhering to the surface in the form of spores, treatment of the seed with formaldehyde as practised for such diseases as stinking smut of wheat and covered smut of barley would not be of any value. The only treatment that has been found satisfactory as yet is the hot water one, used for controlling loose smuts of barley and wheat, which is somewhat difficult to carry out satisfactorily under ordinary farm conditions.

Leaf Spot of Wheat (*Septoria tritici* Desm.) was noticed in the neighbourhood of the Farm and specimens were also sent in from Saskatchewan. In no case, however, was it causing serious injury.

CONTINUED OBSERVATIONS ON FROSTED WHEAT.

In a short paragraph appearing in last year's report (p. 240) reference was made to the effect of frost on wheat. It was pointed out that frost may injure the grain more or less while the wheat is standing in sheaves, being then often in a 'dough' or 'milky' stage and compelled to dry up without the aid of the roots of the still active plant. The statement was made that the injury to grain was less when the frost attacked the uncut grain. It was inferred that frost will thus reduce the energy of germination, which would result in an uneven stand and subsequent un-

evenness in ripening. Unevenness in ripening may be due to other factors as well, but from repeated observations and experiments conducted this year certain important conclusions may be drawn supporting this claim.

Two samples of frozen wheat were secured for experimental purposes. Both samples originated from the same field, but they were remarkably different in appearance. Sample 1 was very dark and much shrivelled, sample 2 was much plumper, but still showed signs of frost injury.

A series of grains of both samples were weighed.

Sample 1, 1,000 grain (average) weight = 21.050 grammes.*
" 2, 1,000 " " " = 30,990 "

Both samples had received identical treatment and were then practically equal as regards degree of moisture.

GERMINATION AND DEVELOPMENT OF SAMPLES (AVERAGE OF THREE TESTS).

Sample.	Sown.	Germination after 6 days.	Germination after 20 days.	Height of plants. July 22.	Date of flowering. Anthers showing.	Ripening of grain Full Ripe.
1	Jan. 22	41%	78.5%	14 inch.	Apl. 27—May 3.	May 28.
2	"	72%	95%	21 "	Apl. 17—Apl. 24.	May 20.

The grain was grown in the experimental greenhouses under identical conditions. The degree of development in both plants grown from the different seeds also tends to show that unevenness in ripening has in this case been due to the frost. It must be realized, however, that, under field conditions, both samples would be sown together, when it is possible that some of the weaker plants might succumb in the struggle for existence, but it is doubtful whether such conditions would entirely eliminate the considerable difference in flowering and ripening. At any rate we would advise the farmers not to cut their grain prematurely even though frost may seem imminent. A little careful attention to the lessons from these observations will no doubt result in preventing to a large extent an uneven stand of wheat in the field.

ILLEGAL TO USE, FOR SEED PURPOSES, POTATOES IMPORTED FROM EUROPE.

The potato harvest of the Dominion in 1911 was considerably below the mark, and as a consequence importations of potatoes from abroad became a universal practice. The total imports of potatoes into Canada from European countries during the year ending March 31, 1911, was 720 bushels. But from October 1, 1911, to March 31, 1912, as many as 200,000 bushels and more have been imported into Canada from Europe. It has been repeatedly pointed out that there exist in several European countries potato diseases new to this country, and owing to the fact that Liverpool is practically the centre of the exportations, and incidentally the centre of a badly infected area, the importation together with the potatoes of one or more diseases into Canada became very probable. The general prohibition of the importation of potatoes from Europe would have been advisable under ordinary circumstances, but partly because our crop was deplorably short, and partly because the imported potatoes were primarily intended for consumption, the question of prohibiting the entire importa-

* 1 oz.=approx. 28 grammes.

tions, though carefully considered, was decided to be inadvisable. But when the planting season approached and inquiries concerning the use for seed of imported potatoes became more and more numerous, it was realized at once that the planting of diseased imported tubers would almost certainly be the means of establishing the one or the other of these undesirable diseases. For this reason the following order in council was passed without delay: 'It shall be illegal to sell, offer for sale, dispose of in any way, receive or use, for seed purposes, any potatoes imported from Europe.'

The use for seed of such potatoes has been prohibited mainly because of the danger of introducing into the Canadian soil two new potato diseases, Potato Canker (*Chrysophlyctis endobiotica* Schilb.), and Corky Scab (*Spongospora subterranea* Johns) (Figure 2). The former of these two diseases has been actually discovered in a shipment from England. Hence, it will be obvious that the repeated warnings have been necessary. Besides, experiments have shown that in our climate and soil European potatoes do not yield satisfactorily. We reproduce herewith photographs of diseased tubers taken from the affected carload of potatoes imported into Canada, showing plainly the peculiar warty outgrowths from the neighbourhood of

Fig. 1.— Ordinary Potato Scab, (*Oospora scabies* Thaxter).

the eye or eyes so characteristic of Potato Canker. Much attention is necessary to establish the identity of the disease in this condition. We have examined a large number of tubers where the primary shoots growing from the eyes have become crushed and mutilated, resembling very closely the appearance of canker. Here microscopical evidence only can reveal the true nature of these growths. This being out of the question where farmers are concerned, from whom one cannot expect the necessary technical knowledge to determine accurately the nature of the trouble, the prohibition of the use of imported tubers for seed purposes became the only alternative. To facilitate this precaution, the following order was also passed by Order in Council:—

'Every person using for seed other potatoes than such as have been raised by himself must obtain, preserve and exhibit on demand, previous to planting, a certificate from the seller or his agent stating that the potatoes to be used for seed have not been imported from Europe.'

The following provisions have been copied from the Destructive Insect and Pest Act and should be carefully studied, as any farmer or grower on whose land this Potato Canker or any Corky Scab disease is subsequently found will be asked to furnish evidence of the origin of the potatoes used for seed. Anybody found to have contravened the Act or any regulation will not only render himself liable to a fine or imprisonment provided under the Act, but will also forfeit the entire crop without any compensation.

'Compensation not exceeding two-thirds of the value as assessed by the inspector, of the vegetation or vegetable matter or containers thereof destroyed by the instruction of an inspector, shall be granted by the Governor in Council upon the recommendation of the Minister, except in cases where these regulations are carried out under the direction of the government of a province not granting compensation, or in the case of potatoes or potato crops.'

'Every person who contravenes any provision of this Act or any regulation made thereunder, shall be liable, upon summary conviction, to a fine not exceeding one hundred dollars, or to imprisonment for a term not exceeding six months, or to both fine and imprisonment. Any vegetable matter imported or brought into Canada contrary to this Act, or to any regulation made thereunder, shall be forfeited to the Crown.'

'The owner, occupier or lessee of any premises or place where any of the insects, pests or diseases specified herein shall be found, shall immediately notify the minister, and shall also send to him specimens of such insects, pests or diseases.'

Any one desiring further information about this Potato Canker is referred to Bulletin 63 of the Experimental Farm series (Division of Botany), and Farmers' Circular No. 1, obtainable free of charge from the Experimental Farm, Ottawa.

"CORKY" SCAB OF POTATOES.

(*Spongospora subterranea* Johns.)

No record regarding the occurrence of this disease on this side of the Atlantic has become known up to date of writing. Although the disease has part of its name in common with the ordinary potato scab it is in no way related, nor does it even closely resemble the common potato scab. Probably the name 'Powdery Scab,' given to it later, describes more closely the appearance of this trouble. The 'scabs' or incrustations on the surface of potatoes in this disease are filled with a powdery, olive-green mass, composed entirely of the spores of the fungus *Spongospora*. They are often present in such dense masses as to appear like the spore powder of smut fungi. The common potato scab (Fig. 1) does not alter the shape of the tuber, whereas the powdery scab (Fig. 2) frequently produces gnarled, knobby tubers covered with deep sores, almost totally unfit for any purpose. The fungus, or more correctly speaking, the slime fungus (*Myxomycete*) belongs to the same group of organisms as that causing Club Root (*Plasmodiophora*) in turnips and other related plants. It produces millions of perforated spores which infest the soil and any sound tubers that may come into contact with diseased ones. The disease is widely spread in Europe, hence it affords one more reason to abstain from using imported potatoes for seed purposes. The great danger of introducing new diseases into any country should be fully realized. The examples afforded by the ravages of the Late Blight of potatoes (*Phytophthora infestans*), which disease has also been introduced from abroad, should suffice to impress any sceptical person of its serious importance and the responsibility of any grower who commits 'an error of judgment.' To spray potatoes, as they should be sprayed, to prevent any losses from Late Blight, costs, inclusive of labour and material, twenty-four dollar per statute acre. This expenditure, however, may save every cent of loss, while spraying to prevent Potato Canker and Corky Scab has been found of no value whatever.

A large quantity of imported tubers have been examined. While it must be said that some were of remarkably fine quality, there were whole consignments that showed Dry Rot, Rhizoctonia, Scab, Late Blight, Sprain and Bacterial Rots to such an extent as to be useless for any purpose.

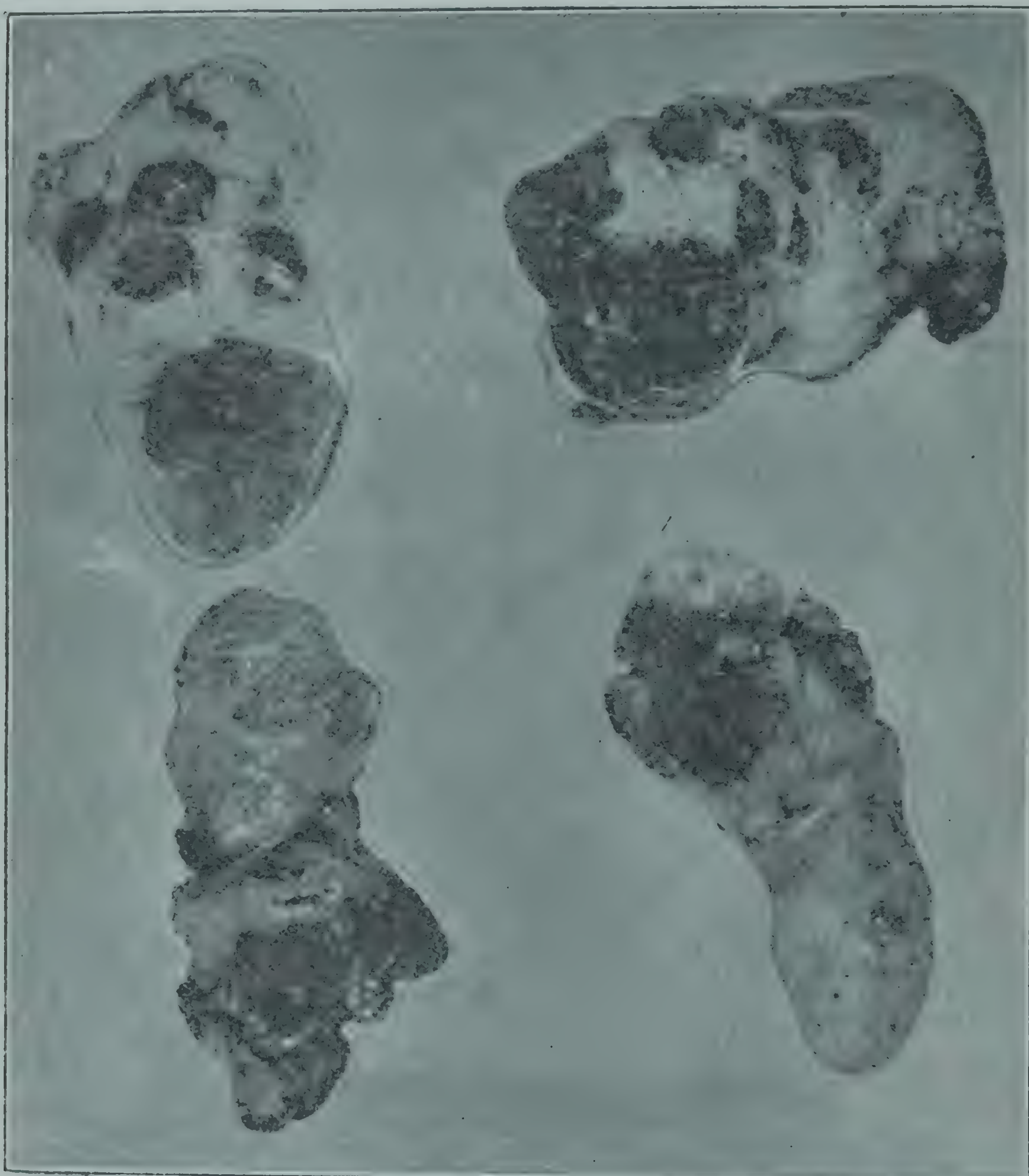

Fig. 2.—Powdery or corky scab Disease of Potatoes (*Spongospora subterranea* Johns.) Potatoes all out of shape, gnarled and covered with sores.

The risks involved from the introduction of new diseases are far more serious than may appear. It is not a question of injuring the crops and purses of one or more growers, but the whole industry of a nation may be seriously compromised. The sooner this question receives international attention the better, for only by international agreement will it be possible to prevent the wholesale exportation of diseased vegetation, and thus the distribution all the world over of diseases against which every country spends thousands of dollars annually in its efforts of control, but which it shows no concern about when exporting into any other country.

'RHIZOCTONIA' DISEASE OF POTATOES.

(*Corticium vagum* B. & C. var. *Solani* Burt.)

(Figure 3.)

Very frequently there may be found firmly adhering to the surface of potato tubers, small, dark-brown bodies of varying form, and ranging in size from a pin's head up to ⅛ of an inch or so in diameter. They are usually comparatively inconspicuous when dry, but on wetting the surface of the tuber they show up distinctly. These bodies are masses of resting mycelium—commonly, but in this case, perhaps, not quite correctly, termed *sclerotia*—of a fungus. Under the right conditions of temperature and moisture, these 'sclerotia' give rise to a characteristic mycelium which was long supposed to be incapable of producing spores (i.e., a sterile mycelium) and placed in the form genus *Rhizoctonia*. In comparatively recent years, however, it has been demonstrated that this Rhizoctonia on the potato is identical with the Basidiomycete *Corticium vagum* B. & C., the latter being the spore-bearing stage. This latter name is therefore given above, as the correct scientific one, while the name Rhizoctonia is also retained as being the one under which the disease is best known.

Fungi similar to the Rhizoctonia stage of the fungus attacking potatoes are also known to cause serious diseases of many cultivated plants, for instance a form of the 'damping-off' of seedlings, and various root and stem rots of beets, beans, lettuce, tomatoes, &c. Whether many or all of these belong to the same species or not remains to be proved, but there seems considerable likelihood of this being the case.

While the 'sclerotia' adhering to the potato tuber are quite superficial and not associated with any rotting or other injury of the tuber, the conditions which have just been mentioned, as leading to the production of mycelium from them, are fulfilled when the tubers are planted. This mycelium which now develops is capable of causing quite a serious disease of the potato crop, attacking the underground stems and roots and also the stem above ground. The effects of this infection show themselves in a variety of ways. Commonly a brown, sunken, 'cankered' area may be found extending along the stem just above the level of the ground. In bad cases this may go right around the stem, 'girdling' it and causing it to dry up. This mode of attack frequently destroys large numbers of young shoots as they make their way above ground. When the tops have reached a fair size, but the underground parts which normally bear the young tubers have been attacked and destroyed to a considerable extent, a cluster of small tubers is often formed at the base of the stem just below the level of the ground. This form of the disease is designated 'little potato'; it is often associated with the formation of small leafy, green or purplish tubers in the axils of the leaves above ground (aerial tubers). Both phenomena in fact are due to the same cause, a surplus of food substances manufactured by the leaves and not used up in the usual way. Sometimes the disease manifests itself in a shortening of the shoot, the leaves being close together. The appearance resulting from this has suggested the name 'potato rosette' commonly applied to it.

The spore-producing or perfect stage of the fungus according to our experience does not seem very abundant. Some very good examples, however, were observed in British Columbia, some have been sent in during the past season from the Province of Alberta, and others were found on the Farm here. It appears to be restricted to the living host plant, and forms an adherent gray very delicate and easily removable layer for a distance of two or three inches or more along the stem or branches above ground.

Diseases due to species of Rhizoctonia are of the kind known as 'soil diseases.' By this is meant that once the organism has been introduced into the soil, it has the

power of persisting there from year to year, waiting the opportunity, so to speak, to attack any susceptible crop that may be planted therein. If, as seems probable, the Rhizoctonia diseases affecting a considerable number of plants are due to one and the same fungus, the danger of introducing the disease into uninfected land is obvious. It is quite true that sometimes the fungus may be present in considerable amount and yet the resulting disease may only be slight, but this is simply because, as with all fungus diseases, other factors, of which for the most part we know little, influence the virulence of the parasite or the resistance of the host. It is at least equally true that when conditions favour the fungus, serious results may follow, and therefore if the fungus be present there is always the danger of such results. Hence it is most important to avoid introducing the fungus into uncontaminated soil.

Fig. 3.—Rhizoctonia Disease of Potatoes. The black spots are the so-called "Sclerotia." In this stage the fungus is carried over from the preceding year.

Although mention has just been made of a spore-bearing stage, yet there is little doubt that the parasite is mainly disseminated by the 'sclerotia.' It would greatly reduce the danger of infecting healthy soil if only tubers quite free from disease were used for 'seed.' As, however, in practice this is almost impossible to carry out, tubers which appear to be free from disease should be selected and subjected to some treatment that will kill any sclerotia adhering to them. For this purpose the treatment so widely used against potato scab is generally recommended, but does not seem to have given uniformly satisfactory results. In this connection an experiment conducted at the Central Experimental Farm this last season yielded some interesting results. Two lots of potatoes, both badly and about equally affected with sclerotia were taken. One lot was soaked for three hours in formaldehyde solution of the strength usually employed against potato scab, viz., ½ lb. in 15 gallons of water. The other lot was soaked the same length of time in a solution of 1 part, by weight, of

Potato Canker (*Chrysophlyctis endobiotica* Schilb.) as it occurred on potatoes imported into Canada from England.

corrosive sublimate in 2,000 parts, by weight, of water. This is half the strength and twice the time usually employed against potato scab. The tubers at the expiration of the treatment were removed from the solution, spread out till dry, cut and planted in beds in the same plot of ground. At harvest time it was found that the tubers grown from the 'seed' treated with formalin were almost as badly covered with sclerotia as those originally planted, while those from the tubers treated with corrosive sublimate were practically clean. It would seem, therefore, that treatment with corrosive sublimate in the manner indicated is much the more effective measure against this disease, while it is certainly just as reliable as the formalin against scab. The chief objection to the use of this chemical is its deadly nature as a poison if taken internally, so that all reasonable precautions should be taken in using it. It should also be mentioned that the solution corrodes most metals and should therefore be prepared in a wooden vessel.

Apart from treating the 'seed' in the manner indicated there is little to be done. No remedy is available for plants once attacked, and applications to the soil seem to have little value. In some Rhizoctonia diseases applications of lime to the soil have been found useful, but such alkaline dressings have a marked tendency to increase the severity of potato scab, and if this disease be also present the amount of harm done in this way would likely more than counterbalance any possible good in the checking of the Rhizoctonia.

The question of distributing this disease by means of affected tubers became very prominent at the time of sending out small samples of seed potatoes from the Farm, when it was found almost impossible to secure sound smooth tubers. For the purpose of preventing this disease it was suggested to treat the tubers in the above manner with corrosive sublimate before sending them out to farmers. The objection, however, was raised that the quantity of poison adhering to the surface of the tubers might have fatal or injurious results, should any of these potatoes be used for food, instead of for planting as intended. To ascertain whether a quantity sufficiently large to cause injury to persons consuming treated potatoes, the Dominion Chemist, Mr. Frank T. Shutt, M.A., kindly undertook to investigate this matter, and the results of his labours are herewith incorporated, with his kind permission:—

Re TREATMENT OF POTATOES BY MERCURIC BICHLORIDE (CORROSIVE SUBLIMATE).

We have carried out a series of experiments to determine the amount of mercuric bichloride that might be absorbed or retained by any given weight of potatoes on treatment for Rhizoctonia.

The treatment consisted in soaking the tubers for three hours in a solution of mercuric bichloride of the strength 1—2000, removing them from the solution and, without rinsing, allowing them to dry by exposure to the atmosphere at room temperature. The potatoes analysed were examined 24 hours after treatment.

Two methods were adopted: the first, a direct one, in which the amount of mercuric bichloride in or on the potatoes was determined, the second, an indirect one, in which the amount of this compound removed from the solution by the potatoes was ascertained. It is satisfactory to note that the results by both methods were closely concordant.

Omitting the details of the various methods used in the analysis of the tubers and the solution, it will suffice to state that we found 3 pounds of potatoes (13 tubers) after treatment to contain, approximately, ·052 grams mercuric bichloride. By analysis of the solution used in their treatment it was found that its content of the fungicide, i.e., its strength, had been reduced 10 per cent, which on calculation showed that 3 pounds of potatoes had removed, approximately, ·05 grams bichloride.

The usual dose of mercuric bichloride is between $\frac{1}{32}$ and $\frac{1}{16}$ of a grain, and the maximum official dose is $\frac{1}{8}$ grain. There are not apparently many cases on record of

fatal poisoning by this chemical, but it is stated by an eminent authority on toxicology that ·19 grams (approximately 3 grains) have proved fatal.

The amount of mercuric bichloride, according to our findings, contained on or in 3 pounds of treated potatoes, is approximately ·05 grams or ¾ grain, an amount equal to 6 maximum official doses. This, in my opinion, would render it highly desirable that the treated potatoes sent out should be accompanied by a statement that the tubers have been treated and are in consequence non-edible.

A fact of some interest that has been brought to light in connection with this treatment is that the strength of the solution is materially reduced by the potatoes. This, I think, points to the necessity of rejecting the solution after it has been used three or four times, and a freshly prepared one substituted.

(Signed) FRANK T. SHUTT,
Dominion Chemist.

From the above analysis it is quite evident that serious consequences may be entailed from the consumption of potatoes treated with so weak a solution as 1 in 2000 corrosive sublimate.

The analysis brought out, however, another very interesting fact, i.e., the material reduction of the strength of the solution. This point has to my knowledge never been exposed, and it seems reasonable to deduce that the removal from the solution of the ingredient used to kill the fungus no doubt accounts for the often limited success in preventing the reappearance of diseases, which might have been assured by employing a fresh solution after treating a quantity of tubers. An experiment will be undertaken with the view of observing the action of the solution by using it over and over again.

PHOMA ROT OF TURNIPS (*Phoma napobrassicae*, Rostrup).

(Figure 4.)

In January of this year a correspondent in Prince Edward Island sent to the Division for examination a specimen of Swedish turnip affected by this disease. According to the statement of our correspondent, the disease was first noticed when the turnips were about half grown. In some instances, the plants were killed outright while still immature, by the disease extending round them, but the chief loss occurred after the roots had been placed in storage, a large proportion of them decaying. The trouble was furthermore stated to be serious in many turnip fields in the vicinity. However, as no other specimens were submitted, it cannot be regarded as certain that the disease was the same in these other cases.

Attacked roots show discoloured areas; beginning near the centre of which the fruiting bodies of the fungus are developed; minute black *pycnidia* containing large numbers of exceedingly minute spores 4 to 6 micromillimeters long by about 2 broad. The affected spots may subsequently break down with a kind of dry rot or, more usually, the mycelium rapidly extends through the tissues, producing a soft rot. The behaviour in this respect will be governed mainly by external conditions, especially warmth or moisture. No doubt, too, in many cases various bacteria and fungi obtain entrance through the tissue first killed and assist in hastening decay.

The disease was first described by Rostrup about 1891 (*Tiddskrift for Landökonomi, R. 5, Bd.* 11: *330*), and a short note subsequently published by him in the *Zeitschrift für Pflanzenkrankheiten* 4 (1894): *322*. Later it attracted attention in England (*Potter, M. C., Jour. Board of Agric., 1900, p. 48*). It is, however, not confined to Europe being well known and destructive in New Zealand as the following extract will show (*Kirk, I. W., Bull. 14 Div. of Biology, N. Z. Dept. of Agr., 1909*) :—

'Large areas of turnips have been ruined both in the North and South Islands, and the disease attained to an epidemic condition within a single season. A feature that is present this year (1908) and which was formerly absent, is the rapid soft-rotting of many of the affected tubers. This in many cases has been almost entirely due to the rapid spread of the Phoma mycelium within the tissues, breaking down the cell-walls, but in other cases bacterial agencies have come into play closely following the infection of the turnip by the Phoma.'

Fig. 4.—Turnip Bulb showing lesions caused by *Phoma napobrassicae* Rostr. (after W. Carruthers).

So far as we have been able to learn, this disease has not been previously recorded from North America, and the finding of it here would seem to add another to the list of parasitic diseases which have gradually become known, and in many cases feared, in temperate climates all over the world. Whether or not the disease is likely to prove as serious here as in the moister climate of New Zealand cannot, of course, be judged as yet, but it is certainly in the highest degree desirable that all reasonable precautions be taken to prevent it from spreading. The fungus, so far as is known, is carried over from year to year in the soil, and therefore the most important control measures should be directed towards keeping soil as yet known to be uncontaminated free from infection. Where the land has borne a diseased crop, the growing of turnips should be discontinued for some years, and care taken not to carry the soil from such a field on implements &c., to healthy land. Spores that have been eaten by farm animals are hardly likely to retain their vitality, but on the other hand, if diseased roots are fed to stock, the refuse left by them containing living spores is almost certain to ultimately find its way to the manure heap, and thus contaminate any land to which such manure is subsequently applied. It would be far preferable to destroy all the affected crop by mixing it with quicklime, or to feed it to stock only after steaming or otherwise cooking it to kill all spores. The sacrifice of a crop in such cases may seem a very drastic measure, but when it is a question of allowing a disease of unknown virulence under our conditions to

establish itself or not, too great care cannot be exercised. Affected turnips do not keep well in storage; a large number of other fungi or bacteria gain entrance through the Phoma lesions and cause a rapid decay of the roots, rendering them offensive by their odour, and disagreeable to the animals to which they are being fed.

CLUB ROOT IN TURNIPS (*Plasmodiophora Brassicae* Wor.)

Club Root, a disease affecting Turnips, Swedes, Cabbages and a large number of cultivated and wild cruciferous plants, has been fully described and figured in the report of last year p. 257 plate XI.

The disease, which disfigures and in many cases renders totally unfit for any kind of use the plants attacked, is becoming more serious and widely spread, so that farmers growing any of the plants susceptible to this disease should practise every means to prevent it or confine its attacks to the most limited areas.

Method of spreading the disease.—The disease is spread through infested soil. Soil carried from an infected field in any way contains a large number of disease germs which will immediately reproduce the disease, when coming into contact with the plants mentioned.

There is every reason to believe that the disease is spread by infected seeds. Seeds may be soaked for half an hour in a solution of 1—2,000 Perchloride of Mercury, which will not impair their vitality in the least degree, and sown when dry enough. This precaution should be employed on clean farms. Turnips sown on infested land without exception will become affected.

Do not throw any diseased portion of affected plants on to the manure heap, but throw them into a pit and apply plenty of unslaked lime. Spraying does not control the disease, as the seat of its attack is underground.

Lime versus Club Root.

Experiments with club root of turnips were outlined, and conducted at the Charlottetown Experimental Station for Prince Edward Island. The Superintendent, Mr. J. A. Clark, B.S.A., kindly took charge of the experiments throughout, and many thanks are due to him for his courtesy and trouble in carrying out so carefully the suggestions. A full account of the experiment will be published after some few years, when it is hoped that more reliable and valuable conclusions may be drawn, which one single experiment hardly admits of. Briefly, the experiment conducted was to try the effect of lime on badly infested land. Plots of 1/20 acre in size received a dressing of unslaked lime at the rates of 150, 100 and 75 bushels per statute acre; a plot of the same size received no lime.

The beneficial effect of liming was very prominent during the year of experiments throughout the plots.

Sound turnips were harvested from the untreated plots amounting to 720 lbs.

Sound turnips were harvested from the plot receiving 150 bush. lime amounting to 2,003 lbs.

Sound turnips were harvested from the plot receiving 100 bush. lime amounting to 2,332 lbs.

Sound turnips were harvested from the plot receiving 75 bush. lime amounting to 1,824 lbs.

Different dates of sowing the seed were also tried with the following results.

Sound Turnips from Average of Plots treated as shown.

Untreated plots.	Lbs.	Treated plots. Lbs.
Sown June 1	168	747
" 15	179	651
" 30	373	664

The experiments will be continued. So far, it is shown that while the application of lime has not entirely eliminated the disease, it has notwithstanding, reduced it.

BITTER PIT OR FRUIT PIT OF APPLES.

A number of inquiries have again been received regarding this trouble, an account of which was given in the report for last year. While not nearly of the same importance in Canada as in some other countries, for instance in South Africa and Australia, it is of special interest from the fact that, notwithstanding a great deal of attention having been given to its study, it has so far received no satisfactory explanation. In Australia it has been considered of so much moment that Mr. D. McAlpine, the leading Australian plant pathologist, has been commissioned by the Commonwealth Government to devote himself entirely to the study of this disease at a salary of $10,000 per annum for a period of years or until a solution is found.

During the past year also two important papers have been published by Australian investigators which record the results of experiments undertaken to demonstrate that the cause of the disease is to be found in the poisoning of certain cells of the fruit by absorbed mineral poisons.

In the first of these papers, by Dr. Jean White, it is shown that spots quite similar to the more superficial ones of bitter pit can readily be produced by rubbing the surface of mature apples with such substances as chloroform, corrosive sublimate and arsenate of lead. It is suggested, therefore, that under orchard conditions 'pitting' is probably due to local poisoning following the entrance of some of the spray material through the lenticels of the fruit.

In the second paper Prof. Ewart, of Melbourne University, shows that the pulp cells of the apple fruit are more sensitive to certain poisons than 'any other known organisms;' corrosive sublimate for example being toxic in any solution of greater concentration than 1 in 10,000,000,000. At the same time, the uninjured cuticle and bloom are remarkably impermeable to such solutions. Young apples were found to be more readily penetrated by dissolved poisons than old ones, but, on the other hand, their pulp cells are more resistant, so that an apple at this stage may absorb a quantity of poison insufficient to cause immediate injury but yet capable of killing a group of cells as the apple reaches maturity. This is suggested as one possible cause of the deep-seated spots, but it is also believed that in this case, as also where bitter pit occurs in unsprayed orchards, sufficient poison may be absorbed by the roots and circulated in the sap to cause the death of the fruit cells. While the results of these recent investigations do not furnish all the data necessary in making specific recommendations for the control of the trouble, the advisability of adding enough lime to spray mixtures, whether fungicides or insecticides, to reduce the soluble compounds to a minimum is emphasized. Aside from this particular factor, if it be really the case that the affection may result from the absorption of naturally occurring mineral compounds in the soil control may still remain difficult or impossible, and further work along this line will be awaited with much interest by plant pathologists.

SHOT HOLE DISEASE SERIOUSLY DESTRUCTIVE TO CHERRIES IN PRINCE EDWARD ISLAND.

The Department of Agriculture of this Province called the Division's attention to the presence of a destructive disease attacking the cherries in the Island. A number of correspondents from Prince Edward Island had previously sought advice concerning the control of this widespread disease. A visit was paid to a number of localities with a view of discovering the cause and suggesting practical means of preventing the further spread of the disease.

Complaints have reached us from many quarters stating that 'all the cherry trees of the Island were being gradually killed.' The disease which certainly was very widespread was recognized on microscopical examination as being caused by a minute fungus of the 'shot hole' group. This fungus, technically known as *Cylindrosporium padi*, Karst., causes a number of roundish perforations of the leaves, which by some people are described as resembling 'gun shot' holes. The attacks of cherries, plums and other stone fruits by this fungus are by no means rare, though in Prince Edward Island the disease was unusually destructive. Correspondents observed that the trees had begun losing their leaves early in June; in some instances complete defoliation had taken place by August.

Naturally the loss of so active an agent in the nutrition of the trees results in weakening their vitality, and on repetition of the attack in the following year, when foliation is sparse already through the injury experienced the previous year, the trees finally succumb, as the result of a combination of causes—the fungus and the lack of nutrition. This was observed in almost every case examined where the trees were found dead.

The fungus prefers sour cherry trees, especially the Morello variety. The trees in Prince Edward Island are mainly wild, sour cherry, and their loss cannot really be considered of much economic importance. We have advised the growers in conversation and through the press to remove all dead and dying trees, and to collect and burn all leaves that have fallen to the ground.

As there is a probability that the fungus may live in the young twigs, it is advisable to protect the trees by spraying at intervals of a week with dilute Bordeaux mixture (5 lbs. sulphate of copper, 5 lbs. lime to 60 gallons of water) from the time the leaves begin to unfold till about three weeks after they have grown to their full size.

It also occurred to us to recommend the planting of a better class of cultivated cherry, partly because of the greater value of the fruit, and partly because the disease causes less damage in sweet varieties. Suitable varieties, no doubt, will be recommended by applying to the Dominion Horticulturist.

'POINT ROT' OF TOMATOES.

This disease, known also as 'End Rot' and 'Blossom End Rot,' was frequently made the subject of inquiry. As the name indicates, the disease is characterized by a rotting of the fruit, beginning at the blossom end. It is most injurious to early fruit, especially in greenhouses. The first sign of disease appears as a dark-coloured or watery spot at the base of the style, usually when the fruit is one-half to two-thirds grown. As this spot extends, the different tissues collapse, producing a flattening of the diseased area. Later, the surface of this area often becomes covered with a black, velvety, fungus growth. The cause of the disease is not quite clear. Various fungi and bacteria are found in the diseased spots, at least in the later stages, and several of these have been considered in different investigations to be the cause. No doubt, when a portion of the tissue has been killed, different organisms may effect an entrance and hasten the rotting, but it seems highly probable that some such injury must first occur, and that it is due to the death of cells in the vicinity of the style as a consequence of drought. It has been conclusively shown that the moisture conditions have a very important relation to the disease, and when the water supply can be controlled so as to be regular and sufficient, as in greenhouses, the loss becomes very much reduced. Under field conditions, the control of moisture is more difficult. When irrigation is not possible, surface cultivation to conserve the moisture should be followed and an attempt made to increase the humus in the soil. Prof. Stewart of

Geneva states that by carefully selecting seed from resistant plants, it is possible in a comparatively short time to secure a highly resistant strain.*

As might be expected from what has just been said, spraying has not proved of any value.

RASPBERRY CANE BLIGHT (*Coniothyrium Fuckelii*, Sacc.)

In August last, Mr. French, Assistant Provincial Holticulturist for British Columbia, sent to the Division from Salmon Arm, B.C., a quantity of black raspberry canes of the Cumberland variety, together with the following observations regarding a disease affecting them: 'It seems to affect only the black-caps. The red raspberries alongside are not affected. The berries become hard and dry early and do not grow as large as the healthy ones. They become hard and seedy with very little juice.' He further stated that in many cases the whole plant ultimately died, and that the disease was doing considerable damage in this plantation.

The symptoms mentioned, though not in complete agreement, suggested the disease studied by Stewart and Eustace, and named by them 'Raspberry Cane Blight,' and which they showed to be due to the fungi *Coniothyrium Fuckelii*, Sacc. (N.Y. Gen. Expt. Station, Bull. 226). A microscopic examination of the British Columbia canes showed the presence of *Coniothyrium Fuckelii* in abundance on many of them. A specimen of an attacked cane was sent to Prof. Stewart, who confirmed the determination.

This disease is a common and destructive one in New York State, and is probably widespread. Its occurrence in British Columbia is of interest as indicating this. It attacks nearly all varieties of cultivated raspberries, both black and red, but there is considerable varietal difference in the degree of resistance. The wild red raspberry may also be attacked. The fungus is confined to the canes, the leaves and fruit being only affected indirectly. Infection apparently takes place chiefly—though perhaps not entirely—through wounds, the effect varying with the point of infection. When infection takes place through the old stub left in pruning, the fungus gradually extends downwards, killing the branches successively as it progresses. When, however, the inoculation takes place lower down on the cane, a partial or total 'girdling' is produced, the bark and wood becoming dead and discoloured. When the 'girdling' is complete, the part of the cane above this point dies, and where it is only partial, the supply of sap to the upper part of the cane, including both fruit and leaves, dries up gradually as the fungus completes its circle of extension around the stem. Attacked canes are noticeably brittle at the diseased spot, on which large numbers of the minute fruiting bodies (*pycnidia*) are ultimately to be found. Spores are produced in great numbers from the pustules and, after dispersal, impart a peculiar, smoky colour to the surface of the cane.

The disease is largely spread in the first instance by means of infected nursery stock. Once introduced, however, into a plantation, any agent that can carry the spores from the diseased plants to healthy canes becomes a factor in its further extension. Wind, rain, insects, and the necesssary operations connected with the crop may all conduce to this, while the fungus may persist for an indefinite period on pieces of diseased cane lying on the soil.

Control measures are not easy to carry out. Where the disease has become serious, it is best to dig up and burn the old plants and set out a new plantation on land where the disease has never appeared. In doing this every care should be taken to obtain the new canes from a plantation where the disease was not present. It is not possible to tell merely by examining the canes at the time of setting out, whether

* I have had an opportunity while visiting Geneva of seeing one of these selected strains of tomatoes in fruit where this disfiguring Point Rot had been entirely eliminated.

they are diseased or not, as the fungus may be present in them but the effects not yet visible. The plantation from which they come must be examined about fruiting time or the young plants bought under a guarantee. Cutting out and burning the old canes immediately after the fruit is picked will help to check the disease after it has once appeared. Spraying has not been found satisfactory as a method of control.

BLIGHT OF GINSENG (*Alternaria Panax,* Whetzel.)

While ginseng is not cultivated in Canada to any considerable extent, one or two inquiries have been made by Ontario growers regarding this disease and its treatment. The disease is due to the fungus *Alternaria Panax* which, presumably, winters over in the mulch or plant remains in the soil. As the ginseng shoots push their way up through the soil in the spring they become infected by the fungus, the first diseased areas appearing on the stem near the level of the ground as dead, brown, cankered spots or lines. In these spots the spores of the fungus are produced and the disease is spread by them to the leaves where it is usually more conspicuous. The spots on the leaf are very characteristic being large, more or less circular in outline, often confluent, and of a watery appearance. As the disease progresses, the leaf tissue dries out and the spot becomes papery in texture with a yellowish or brownish tint. Usually wet weather and high temperatures are necessary for the disease to become epidemic, and under such conditions it may spread so rapidly that all parts of the plant above ground may be destroyed in a few days. In specimens recently examined the fungus had attacked and grown profusely on the crown of the root.

Control.—The chief preventive measure consists in spraying with Bordeaux mixture. To be effective, this must be applied so as to protect, as far as possible, the young shoots against the first infection. The first spraying must, therefore, be given soon after the young shoots appear above ground and the application must be repeated every two or three days until they are well advanced in growth. Subsequent sprayings should be given at intervals of 10 to 14 days. In some cases, injury has followed the earlier sprayings, this being due to frost occurring after the application. It is therefore advisable to avoid spraying when there is reason to expect a sharp frost ensuing just afterwards.

LEAF SPOT OF IRIS (*Heterosporium gracile,* Sacc.)

Leaves of cultivated Iris are often attacked by this disease, and, less frequently, those of Gladiolus. It is also recorded as affecting a number of other iridaceous plants both in the greenhouse and out-of-doors. The disease shows itself as small round, elliptical, or occasionally more elongated spots of a pale-brown colour, but surrounded by a conspicuous dark-brown border. Most of the spots are usually small, but the large ones may be half-an-inch in length. The centre of the spot becomes paler with age and ultimately shows numerous minute, black points which are the tufts of spore-bearing hyphæ. The leaf tissue adjacent to the spots also becomes discoloured, and, when these are numerous, the whole leaf withers up prematurely.

Usually the disease does not develop extensively until comparatively late in the season, and the injury done to the plants is not, therefore, so serious as would otherwise be the case. Affected leaves should be removed and destroyed as soon as noticed. In this way, the spread of the disease will be checked. Where the disease has been at all severe, all dead leaves and refuse from the attacked beds should be gathered together and burned in the autumn. If allowed to remain on the plants, the fungus is found to develop abundant spores very early in spring, and the disease is almost certainly perpetuated.

BLACK SPOT OR LEAF BLOTCH OF ROSE TREES (*Actinonema Rosae* (Lib.) Fr.)

This is a common disease of rose bushes and was very noticeable around Ottawa last season. As indicated by its English names, the disease appears as black spots or blotches on the leaves. These occur on the upper surface. Individual spots are usually of small size—a quarter of an inch in diameter or less—but, when numerous, become confluent into irregular blotches of varying extent. Not infrequently the entire surface of the leaflet is thus blackened. The margin of the spot is uneven and not very sharply defined, while a close examination of the surface under a lens shows a radiating network of fungus threads. The leaf tissue around and between the spots generally turns yellow and the affected leaflets fall prematurely. Badly attacked bushes become completely defoliated much before the usual time.

Control.—It is important that the fallen leaves with the fungus on them should be collected and destroyed as far as possible, since these harbour the fungus till the following season. Early in the year before the buds burst a 'cleansing spray' should be applied to the bushes to destroy any adhering spores, and care should be taken to also spray the surface of the soil around the bushes. For this early spraying strong Bordeaux mixture (6-4-40) or a solution of 1 lb. copper sulphate in 40 gallons of water may be used. After the leaves appear, weekly sprayings may be necessary. Bordeaux mixture is satisfactory for this purpose, but produces a somewhat unsightly effect with ornamental plants. It is therefore preferable in such cases to use ammoniacal copper carbonate. Spraying should be discontinued while the plants are in bloom. Much may be done towards reducing the severity of the disease by taking cuttings from healthy plants.

DODDER ON CULTIVATED ASTERS.

In the month of September, a letter was received from a firm of florists in Ontario, asking advice regarding an abnormal condition of a bed of China or Garden Asters (*Callistephus hortensis* Cass.). Specimens of affected plants being submitted to the division for examination, it was found that they were badly parasitized by a species of Dodder. It is well known that *Cuscuta Gronovii* Willd., our commonest native dodder, has a large number of different hosts amongst both wild and cultivated plants, and it was thought likely that this species would be the one responsible for the trouble in the case under consideration. Closer examination, however, showed that the species was *C. arvensis* Beyr. The interest of this lies in the fact that this species is chiefly found on clover and alfalfa amongst cultivated plants. A sample of the seed from which the Aster plants had been raised was found to be quite free from that of any species of dodder and it would seem, therefore, that seeds must have been present in the soil from a preceding attack. No particulars, however, were available in regard to this. The pulling and burning of all the plants in the bed was recommended, and since there seemed a likelihood that some of the dodder seed had matured, it was also advised that asters be not grown there next season.

A specimen of a dodder plant was also sent in from a greenhouse Geranium, but as flowers had not yet been produced the species could not be determined.

EDIBLE FUNGI.

The Morels (*Morchella* sp.).

There are few kinds of fleshy fungi more distinctive in appearance than the various species of Morel, and since none of them are poisonous or disagreeable but all are possessed of excellent culinary properties, they may be gathered and used with perfect confidence by persons who might find considerable difficulty in separating some other edible fungi from allied species capable of producing unpleasant effects.

The size varies considerably with the different species and also among individuals of the same species, the height being from one to six inches. The larger ones are the more desirable for cooking purposes. Each individual usually consists of two well-marked portions, a stalk and a cap, which again are generally quite continuous. Both stalk and cap are hollow, and the latter is of a more or less conical or oval form. When young, the cap is generally yellowish in colour, becoming darker with age. Old specimens are often of quite a dark-brown tint. The stalk is much paler in colour than the cap. The most characteristic thing, however, is the peculiar structure of the cap whose external surface is furnished with plates or ridges branching and uniting again in such a way as to form a complete network, the meshes of which enclose deep, more or less polygonal, pits.

The Morels appear early in the season and grow in shady places such as the borders of woods or the more open spaces therein. They may often be met with in considerable quantities, and, when more are gathered than can be used at once, they may be dried and kept for winter use, when, after soaking over night in water, their delicate flavour will be found well preserved. Morels are generally very sandy, and should be carefully washed and cleaned before use, otherwise the enjoyment when eating them will be much reduced.

AGRICULTURAL BOTANY.

The number of plants submitted for identification showed a considerable increase over last year. No new weed was brought to our attention, but some of the well-known weeds like Devil's Paint Brush, Lamb's Quarters and Field Bindweed seem to gain firm possession of some farms, and, where no vigorous methods for their eradication have been employed, they have come to stay. Again there were many inquiries concerning the suspicious nature of the common,

FIELD HORSETAIL (*Equisetum arvense* L.)

on which further observations were made. The poisonous nature of a closely related species of Horsetail, *Equisetum palustre* L.—by no means rare in this country—has been established beyond a doubt. This plant is correctly considered a highly injurious weed, both in the green and dry state. It is the common experience of observers, however, that, in the green state, this plant, and indeed a large number of other poisonous plants, is rarely eaten by stock; their power of discrimination serves as a fairly safe protection. As a rule, young and inexperienced animals fall victims to poisoning by plants more readily than do older animals. In the dry condition, in hay for instance, no animal is able to select its food, and hence the largest number of indisputable cases of plant poisoning are due to giving contaminated hay as food. Another point of interest is that some kinds of animals are far more susceptible to plant toxins than others. Thus pigs and sheep are singularly immune. Cattle and horses also vary greatly in their susceptibility. *Equisetum palustre* L. is far more serious to cattle, indeed often proves fatal, while it causes but slight trouble to horses.

Equisetum palustre L. has long been suspected as being a fatal poison, and the most recent investigations confirm this conclusion.

As regards the common Field Horsetail (*Equisetum arvense* L.), however, opinions continue to differ, some investigators regarding it as quite harmless, others as of slight importance as a weed injurious to stock from a merely mechanical aspect. In our experience, cattle do not suffer any inconvenience at all from this weed, or only very slight disturbance of their digestive organs, while horses seem conspicuously subject to fatal poisoning by this species.

In co-operation with Dr. Rutherford, Veterinary Director General, we have been enabled to collect some very important data concerning this herb. A considerable number of cases of horses being mysteriously poisoned led to an examination of the herbage being made by a trained botanical assistant, and the constant association of this weed with such cases ultimately induced me to publish a short note in the report for the year ending March, 1910, warning the farmers against this weed (Dominion Experimental Farms Report, 1910, p. 280). Meanwhile we have continued the investigations, which have now established that the common Field Horsetail is seriously poisonous to horses.

A considerable number of cases of horses being poisoned have been reported during the last year, and an examination of the hay on which they were fed revealed in every case the presence of this species of Equisetum; moreover, as soon as the food was changed, the horses, if not too seriously affected, made a rapid recovery. In no case was there present any other poisonous weed that could have been responsible for the trouble. Also the symptoms recorded by veterinary surgeons who have investigated the disease were the same in every case, so that the evidence is very conclusive.

After calling attention to the properties of this weed, a large number of inquiries were received, which showed that cases of poisoning were occurring far more frequently than one would have been led to believe.

One typical case was brought to our notice by an experienced veterinary surgeon which it is desirable to quote, as it appears of considerable interest:—

'We have a very common and peculiar disease in this locality which I call a form of spinal meningitis.

'Symptoms.—Staggering gait, partial loss of motive power, very excitable and good appetite.

'As disease progresses, mucous membrane congested, constipation, urine highly coloured, complete loss of motive power, deglutition lost, heavy breathing convulsions and death.

'In all the numerous cases that have come under my notice and treatment, I find a certain rush or weed in the food, which I am forwarding to you.

'I honestly believe the toxins from this weed are the cause of this disease, and I further know that there is little use in treating patient if allowed food with weed in it, for they seem to have a craving for weed if once affected with this disease. The patients, if still able to stand, if the weed is kept away from them and internal antiseptics, etc., used, will recover to perfect health.'

The weed submitted to me for examination was *Equisetum arvense*, L., common field Horsetail. The description of the symptoms of the diseased animals agrees very closely with all other records and those known of cases of poisoning by *Equisetum palustre*, L.

Any one observing these symptoms should at once change the food, and submit a sample to us for examination. Dr. Rutherford kindly informs us that the treatment which he recommends, and which has been proved successful by those who have had the opportunity of investigating cases of poisoning by this weed, consists of a liberal allowance of clean, easily digestible foods, the administration of a sharp purgative followed by good-sized doses of nux vomica (two teaspoonfuls in food three times a day).

When this treatment is begun before the horses lose the power to stand and can be kept on their feet, their lives can be saved in practically all cases.

In conclusion, it may be said that these weeds grow commonly in moist, undrained localities; they will soon disappear if proper drainage is provided. It may also be useful to encourage the growth of good fodder grasses by giving the land a top dressing with seed at the rate of 10 pounds per acre. This would tend to reduce the percentage of the Horsetail in the hay, though this practice should not be considered a solution of the problem.

BROOM CORN AND ITS POSSIBILITIES IN CANADA.

Broom corn is a plant belonging to the Grass family It is closely related to the Sorghums, Millets, &c. The main difference, however, from the common plants of the genus, is the peculiar character of its panicle or seed heads, which consist of a series of long, straight, upright branches. These seed-bearing stalks are of considerable flexibility and a bundle of them tied together form a very useful and durable broom. It is for this product that broom corn is mainly cultivated. Canada imports nearly all broom corn or manufactured brooms from the United States and Europe. During the present year of report, raw material and the manufactured article imported represented the value of about $420,000.

Broom corn is raised at present in Canada to a very limited extent, the fact of the value of the imported material and the information supplied by one of the foremost manufacturers in this country stating that there is a ready market for all the broom corn that could be grown in Canada, not only justifies but encourages careful attention to the possibilities of the crop in this country. Repeated inquiries have manifested the interest taken by some farmers in the raising of this crop. Exaggerated rumours of high prices, like $150 to $200 per ton which this product has on rare occasions commanded, naturally excited the curiosity and speculative tendencies of a certain class of people, but the more conservative estimate of $80 per ton and the fair yield of about one-third of a ton per acre should suffice to show that no great wealth may be rapidly gained from this source.

The successful growing of broom corn is much more dependent upon suitable climatic and soil conditions, than upon cultural methods, which differ little from those required in the raising of Indian corn. A fertile soil is necessary to produce a good 'brush,' which is the manufacturers' term for the seed-bearing heads; the plant is subtropical, and hence requires a warm, sunny climate. There is no reason to believe that there are not some localities in Canada suitable for the culture of broom corn.

In order to speak more authoritatively on the subject, we conducted a series of experiments with broom corn during the year in many different localities. The interest which these experiments have created amongst many farmers, although no perfect crop was raised anywhere, makes it desirable to continue them on a somewhat larger scale, many farmers having declared their readiness to carry out experiments on their own farms. It is hoped that in a few years satisfactory evidence may be produced in favour of or against the raising of broom corn in Canada.

As one of the more successful experiments as regards size and quality of 'brush' may be considered the one carried out at the Central Farm.

During 1911, only three varieties were tested; to begin with, the seed was not of the first class and the stand was uneven. We hope, however, for more success from the experiments to be conducted this year, when a full report will be issued.

SABLE ISLAND.

Dr. Wm. Saunders, C.M.G., the late Director of the Experimental Farms, began in 1901 a series of experiments on this lonely and exposed Island, in order to introduce some resistant kind of vegetation which would be useful in preventing the blowing of the sand and the wasting away of the coast by the action of the waves. An interesting account of Dr. Saunders' visit will be found in the report of the Dominion Experimental Farms for 1901 pp. 62-77.

The main difficulties against the establishment of trees and shrubs on the island are the absence of any depth of soil,—only three or four inches of partly decomposed vegetable matter has collected in some places—the extraordinary force of the wind, which blows often 80 miles per hour and more, the grinding power of the loose sand

itself, the rapid covering with sand of low-lying, rather more protected areas, and finally the blowing away of sand where trees might succeed, which lays bare their roots in a very short time.

Bearing these extraordinary combinations in mind, it cannot surprise anybody that very little success accompanied the planting of the many trees and shrubs, which were brought by Dr. Saunders to the island under many difficulties, and which received every care from the island's hospitable superintendent, Mr. R. J. Boutellier.

The main vegetation of the island consists of a very coarse, but useful sand-binding grass—*Ammophila arenaria*—which grows to a height of about two or three feet, but, owing to the prevailing winds it is bent down affording thus only protective covering for a height of a foot and a half or rather less. Only about 30 of the 80,000 trees and shrubs planted in 1901 have survived, but none grew above the protective height of the grass. As soon as any growth appeared above this line, the loose sand got hold of it and ground it down in a few hours during a storm. There is no protection afforded by the many sand hills, all sides are exposed to wind and weather, one side fills in, while the other is scooped out again. The incessant changes in the direction of the wind are naturally against the survival of even those trees and shrubs which have done well under similar but yet so different conditions. The erection of storm fences, which have proved satisfactory in many similar circumstances, have proved equally unsatisfactory on Sable Island. A few willows, an American elm and some roses have survived behind fences surrounding the house of the superintendent, but the leaves that may incautiously venture above the fences are rapidly lacerated by the sand or dried up in the everlasting wind.

During a few weeks visit, I observed with great surprise how eagerly the wild ponies and cattle devoured the coarse grass, which no doubt would cause considerable soreness to the mouths of the mainland animals. Yet Sable Island ponies thrive on it, and I have been told by Mr. Boutellier that they do not seem to relish timothy hay sent from the mainland in years when there is poor haying on Sable Island. The fact that this grass possesses a highly nutritive character has been clearly demonstrated by the interesting chemical analysis of it made by Mr. F. T. Shutt, M.A., the Dominion Chemist, who states that it is quite equal in protein or albuminoids to many of our highly esteemed cultivated grasses.

The question of preventing the blowing of the sand and the washing away of the shores of this island, which is a most important point of support for two lighthouses marking an extremely dangerous region of shallow spreading submerged banks, so disastrous to many a vessel, is still as prominent and unsolved as ever. After a very careful survey of the floor of the island, and in consideration of the already quoted aggravating difficulties, a probable solution may lie in the direction of encouraging and propagating as much as possible the vegetation already on the island.

During the time of my visit in August and part of September, of course a large number of plants had disappeared, or at least were no longer conspicuous by their flowers or seeds, but still about 150 different plants have been observed and collected. The vegetation on the whole affords excellent examples of the survival of the fittest, or adapation to environment, as well as remarkable features of ecology. The flora is a curious assemblage of maritime, fresh and salt water, European and American plants, and it is hoped to complete a collection of the plants on Sable Island some other time when a visit earlier in the season would augment our collection considerably. A thorough knowledge of a flora thriving on such an exposed and sandy island would be very useful in many instances where such plants may be requisite under conditions existing on the mainland.

Sable Island is very productitve of blueberries, and still more of cranberries, of which as many as 60 apple barrels-full may be collected in some years. The col-

lection and export of these fruits may be regarded as an important factor in preventing the perpetuation of this vegetation by seed, but it cannot be said that this practice is really detrimental, because there are many localities where berries are never collected, and where sufficient seed is produced. The berries grow to excellent size, and often 3 to 5 fruits may be found attached to a single stem.

There is a peculiar absence of pollenizing insects on Sable Island which would be instrumental in the act of propagation of many plants. This difficulty might be successfully overcome by the keeping of bees at the various stations. There would be food in great quantity for the bees and the honey might equal the famous moor honey of Yorkshire, where bees feed on a very similar vegetation. The keeping of sheep might also serve as a very useful measure, the close feeding of certain vegetation, the compacting of the ground by their feet and their valuable manure would tend to increase root action and produce a firmer surface. At any rate it seems clearly established that little benefit will result from the introduction of trees and shrubs on Sable island.

BOTANIC GARDENS.

One of the main purposes of a Botanic Garden is to enable the visitors interested in any particular plant to ascertain its correct name. For this purpose we have begun labelling the plants with plainly printed large labels of a permanent character. This work entails considerable painstaking and careful research owing to the difficulty of the everchanging nomenclature of plants. When, in a year or two, all plants have been labelled in this way the gardens will be much increased in value to the general public and the student of Botany. A number of new plants have been added to the collection and many are being raised from seed.

On October the 24th the garden was honoured by a visit of Their Royal Highnesses the Duke and Duchess of Connaught, who seemed to be much impressed with the beauty and variety of our Canadian flora as far as represented in the gardens. Before leaving Her Royal Highness the Duchess further honoured the gardens by planting a memorial tree in what may be said to be the most beautiful spot in the whole gardens.

It is to be regretted that certain elements among the public make themselves guilty of vandalism. Pure carelessness of some visitors has spoiled many a carefully tended plant. At Christmas time the large and beautiful collection of Conifers is much exposed to wanton destruction by persons stealing their tops for Christmas-trees. Nothwithstanding every precaution, some valuable trees are lost in this way every winter. It is hoped that every visitor will bear in mind that the gardens are solely maintained for an educational purpose. Though we cannot boast at the present moment of an exceptionally beautiful park, on account of its comparatively recent establishment, yet in years to come when the vegetation will have outgrown its artificial appearance, our gardens will certainly be one of the most beautiful on this continent. This reserve may be well considered a national property, and should be the pride of the people of Ottawa.

Over four hundred different species of viable seeds were collected during the season of 1911 from plants in the gardens. A list of these was prepared and sent for purposes of exchange to the Botanic Gardens in different parts of the world. We were thus able to supply desiderata to other institutions, and were fortunate enough to secure a considerable number of seeds in exchange which will be added to our seed-collection and used to raise plants for our gardens. It is hoped that our list of seeds for exchange will be greatly enlarged, and that we thus will be able to make returns for some of the privileges accorded us by the courtesy of other institutions during the many years of existence of our own.

SEED EXCHANGE.

We are also much indebted to the Office of Foreign Seed and Plant Introduction at Washington, D.C., for many new plants which were received from this source.

In the endeavour to increase our collections we shall always appreciate any interest shown by private individuals and by kindred institutions; it will also be our aim to supply any demand for particular species of plants that may be desired by other persons who are interested in the same pursuits.

HERBARIUM AND SEED COLLECTION.

Scientific collections become enhanced in value if they are systematically and uniformly arranged. Thus in the rearrangement of the plants in the Botanic Garden, the Herbarium, and the seeds of the same, according to Engler and Prantl's system of classification, we have adopted the method of uniform indexing so that the growing plants, dried herbarium specimens, and seed of the same kind will be found under the same entry number, and thus are for more easily found by students even though they may not be familiar with the collections themselves. An interesting series of sheets has been added to the herbarium comprising the collection made on Sable Island. The collections all show the normal increase.

Some time was devoted by my assistant, Miss Faith Fyles, B.A., to preparing pen-and-ink and water-colour drawings for the report and other divisional publications, as well as for useful records of rare flowering plants, and plant diseases. This work is of great importance in enabling the farmers to more readily recognize the appearance of certain diseases of plants, and to identify noxious weeds and poisonous plants as the case may be. The division is exceedingly fortunate in having a member on its staff whose skill in this work is so exceptional. Many photographs have also been taken where it was thought necessary to keep special records.

In conclusion, the thanks of the Division are due to the many correspondents and other botanists who have readily assisted in the progress of the work or in adding to our collection.

DOMINION OF CANADA

DEPARTMENT OF AGRICULTURE

DOMINION EXPERIMENTAL FARMS

REPORT

FROM

THE DIVISION OF BOTANY

For the Fiscal Year Ending March 31, 1913

PREPARED BY

The Dominion Botanist. - H. T. Güssow

REPORT

OF THE

DIVISION OF BOTANY.

J. H. Grisdale, Esq., B.Agr.,
Director, Dominion Experimental Farms,
Ottawa.

Sir,—I have the honour to submit herewith the report of the Division of Botany for the year ending March 31, 1913, being the fourth annual report of this Division.

The present report is an account of that part of the work carried on by the various members of the staff of the Division, which is considered to be of more general interest. It is a bulletin of miscellaneous botanical information and appears in a somewhat changed form, inasmuch as it is partially prepared by the several members of the staff under their own names instead of, as heretofore, by the Dominion Botanist.

While all work in the Division is carried on under the direction or with the approval of the Dominion Botanist, the varied character of that work renders it necessary that individual members of the staff devote themselves largely to different lines of work or the solution of special problems. It is hoped that by reserving the credit for original work done by them, and thus stimulating them to acquire a scientific reputation of their own, the present arrangement will encourage such work and thus contribute to the raising of the standard of the report from both the scientific and the practical standpoints.

The work of the Division has extended considerably and progressed satisfactorily during the past year and I am pleased in this place to acknowledge the ever-ready assistance rendered by the members of my staff.

I have the honour to be, sir,
Your obedient servant,

H. T. GÜSSOW,
Dominion Botanist.

MILK BACTERIOLOGICAL INVESTIGATIONS.

During the year the Division conducted an inquiry into the bacterial contents of the milk produced by the Farm herd. It was first necessary to examine the bacterial contents of the natural milk; and also to inquire into the sources of any bacterial contamination with a view to eliminating, as much as possible, impurities of such character.

The investigations required much time and thought, since, as they progressed further, new phases of work had to be taken up; partly because of the limitation of space in this report, and partly because the experiments will be continued, we only give a brief progress report here and reserve the publication of all details for an exhaustive report to be published later.

In order to familiarize the manual staff of stable and dairy with the meaning of 'bacteria,' the Director requested the Dominion Botanist to give a series of demonstrations and addresses before these men, which were well attended and which resulted in establishing the deeper interest of the men in the various experiments which became necessary. Owing to the interest manifested, the series of addresses proved a real pleasure to the lecturer.

Because of the scientific nature of such work, some very elementary explanations became necessary, and the nature, development and significance of 'bacteria' were carefully gone into.

The work itself may be divided into three main groups:—

1st. Experiments made with a view to discovering and eliminating sources of bacterial contamination of milk.

2nd. Quantitative examination of milk before and after certain measures suggested for improvement.

3rd. Comparative quantitative examination of bacterial contents of milk, as produced by hand milking and machine milking.

SIGNIFICANCE OF BACTERIA IN MILK.

Before giving an account of the various phases of the work carried on, a few remarks as to the meaning of bacteria in milk may be welcome.

The bacterial content of milk varies naturally according to the health of the animal from which the milk is obtained, and the treatment and care the milk receives thereafter. For the examination of the bacterial contents, a small quantity of milk is generally sufficient. One cubic centimeter (or 1 'cc.' in its usual form of abbreviation) is commonly examined. This quantity is taken from an average, representative sample by means of an absolutely clean and sterile graduated pipette or glass tube, the capacity of which is accurately measured. This is dipped in the milk and the latter drawn up by gentle suction. According to the size of the pointed mouth of such a pipette one cubic centimeter will 'drop' from 20 to 25 single drops of milk. Hence, a cubic centimeter is equal to a quantity of from about 20 to 25 drops of the liquid examined. There are 568·34 cubic centimeters in the imperial pint.

Bacteria are amongst the smallest organisms of plant life and owing to their purpose in nature are most abundant where dirt and filth accumulate and where the conditions are generally unsanitary. They are principally scavengers of nature and cause the decomposition and final disappearance of any kind of vegetable or animal matter. In this respect they are decidely useful, but no one would consider them a useful addition to the milk or food consumed. They must in such place be considered as impurities and in the nature of contamination.

While most kinds of these organisms are not actually disease-causing, yet they may very quickly spoil for human consumption milk and other food that would remain wholesome otherwise. Where, however, the bacterial purity of milk becomes of great moment, is at times when certain germ epidemics prevail, such as typhoid, cholera, infantile diarrhœa, and also the ever-present scourge of mankind, tuberculosis. All of these serious diseases have been communicated by means of infected milk, and for these reasons the freedom of milk from disease-causing organisms especially, is one of the most vital necessities of the milk supply of cities.

The work was begun in July, 1912, and preliminary investigations were carried out to discover the sources of bacteria in the milk.

Thus the bacterial content of the stable air were examined, when the floor was dry or sprinkled with water, also several kinds of bedding were tested; the cows were also bacterially inspected before and after cleaning in order to keep trace of bacteria falling from the animals into the pail during milking.

The men engaged in milking were cautioned to observe particular cleanliness. The hands of the milkers were examined occasionally for bacterial contamination; also the milk pails, cans, bottles were carefully examined before and after special cleaning operations. In this manner some very interesting data came to light, and after eliminating the sources of contamination as much as possible, the bacterial contents of the milk were then regularly examined. From time to time check examinations were made in order to discover any infringements of the rules of sanitation.

About a week was required to get the results to coincide, which they very accurately did after that time.

At first, hand milking was employed alone. From July 25th, a milking machine was put into operation and comparative tests were conducted to find out by which method the purest milk could be obtained. Throughout our tests, the hand milk was cleaner than the machine milk. The reason for this was that the rubber tubing of the milking machine soon got into a condition where no matter how carefully cleaning was practised, it could not be made quite sweet and pure, but when the old tubing, etc., was changed for new, the bacterial purity immediately improved.

It was also found that the milk cans sent in by dairies to receive milk at the farms were far from being bacteriologically pure.

A new cotton wadding filter was tried, the milk being tested with and without its use. At first, the contents of the unfiltered milk was lower than that of the filtered milk. After cleaning the filters properly, the unfiltered milk was less pure. Very little gain resulted from the use of these filters as far as bacteria were concerned. Dirt, etc., was, however, very satisfactorily removed.

The effect of a milk cooler on the bacteria contents was also tested. The immediate cooling of the milk was found of great service in preventing the increase of bacteria that occurred in uncooled milk.

Comparative tests of several types of milk pails were also made. Each type of pail was in use for the same period, and the results were in favour of the hooded pails.

It will be of interest at the present time, where several types of milking machines are in use at various places, to give in detail some of our comparative tests of milk obtained by machine *versus* hand milking.

Date.	Machine Milk.	Hand Milk.
1913.		
February 24	25,416 bacteria per "cc"	975 bacteria per "cc".
" 25	20,883 " "	6,579 " "
" 26	2,188 " "	1,455 " "
March 6	6,244 " "	1,008 " "
" 7	22,993 " "	1,700 " "
" 8	10,454 " "	1,700 " "
April 1	21,141 " "	350 " "
" 2	12,760 " "	919 " "
" 3	21,427 " "	391 " "
" 4	7,850 " "	847 " "

From the above ten days quoted in detail, the average daily counts for the milking machine are 15,135 organisms per cubic centimeter, and 1,590 organisms per cubic centimeter for the hand milk. The average for another similar period gave 174,693 organisms per 'cc.' in machine milk and 2,706 organisms per cc.' in hand milk. A third average computed from a period of twenty days again decided in favour of hand milking; the results obtained for machine milk were 22,112 per 'cc.,' and for hand milk, 9,358 per 'cc.'

The average bacterial contents of milk obtained by machine and by hand of all tests made, were as follows:—

Machine milk per 'cc.' 70,646 and hand milk per 'cc.' 4,551 organisms.

Notwithstanding the variations of the bacterial contents obtained at certain times, the differences have often been easy to account for. For instance, on February 24th and March 7th, some teat cups fell off during milking and before the cow could be attended to, dust and dirt had been absorbed by suction and had spoiled the milk, which though examined, was, naturally, rejected. Again, in hand milking several times the milker was changed and less experienced men had to be employed; this at once increased the number of bacteria per cc. of milk.

The experiments are being continued and finally a complete report will be issued. At the present we are able to state that the bacterial contents of the milk have been reduced after six months' work from 18,000 organisms per cc. at the beginning to some 500 organisms towards the end. Thus the milk at the Central Experimental Farm may be classed among the purest natural milks produced anywhere on the continent of America.

THE STORAGE ROTS OF POTATOES.

For some months past, an inspection of stored potatoes has been carried on by the Division of Botany, especially of potatoes among which the presence of powdery scab was suspected. During this work it was recalled that the losses from the various 'rots' affecting stored potatoes were considerable, and of far greater economic importance than is generally realized. In some instances from thirty to forty per cent of the potatoes had become quite useless, owing to various forms of dry or wet rots. This observation made early in the season was a bad outlook for the safe-keeping over winter of the remaining potatoes. 'Storage rots' of potatoes may be induced by a variety of agents. To begin with, it must be understood that a perfectly 'ripe' potato providing, of course, it is free from blight or other diseases, is less liable to be affected by rot than those harvested too early. This statement raises the question: When are potatoes ripe, *i.e.*, in the best condition to dig? Digging potatoes depends largely upon individual conditions prevailing at the

various farms; in wet land it is advisable to dig them earlier than on dry land; they will also have to be dug at a later date when badly affected by blight, in order to show the disease in the tubers, so that they may be removed, than if they were free from it; but in general potatoes are ready for digging, under normal conditions, when the stalks have died down and hence no longer take an active part in the manufacture of the reserve food which is stored in the tubers. Here it is where the psychological moment may be missed, for there are potato diseases such as late blight, early blight, rhizoctonia, or even the attacks of the flea beetle or potato bug, which may cause the premature death of the stalks, and which may be mistaken for their normal 'death.' Where these conditions prevail, the potatoes underground are not 'ripe,' and, what is more important, there is no chance of their becoming ripe, however long they are left in the soil.

A ripe potato has all its cells well supplied with food material, *i.e.*, starch, and the skin adheres firmly to the tuber when the finger or thumb is applied to the surface with a firm, rubbing movement. When the skin is easily detached during this operation, the tubers are not ripe and should be left in the ground, providing the tops are free from disease. It is an unfortunate fact, however, that the largest percentage of potato fields are attacked by late blight and the stalks are killed prematurely. In this case the tubers will also have become infected and are liable to decay in the pit or cellar, unless certain precautions are exercised.

The second fact favouring, and indeed inviting decay, is where potatoes are lying too close to the surface of the ground in the field. Such tubers are easily touched by frost, and, if not separated at once from those unaffected, they are sure to decay when placed in storage.

Another prominent source of rot in storage is the apparently unavoidable injuries during harvesting of potatoes, especially when a potato digger is used. However slightly a potato may appear to be damaged, as soon as the injury extends below the skin, the tissues rich in available food are open to an invasion by scores of fungi and bacteria, which find in such wounds a very suitable feeding ground. A large number of such injured potatoes are picked up, notwithstanding every care, and are finally deposited in the bins or pits.

The above mentioned factors, involving more or less mechanical or physical features, deserve, nevertheless, to be taken into careful consideration. The conditions described on the potatoes themselves, which may be regarded as factors weakening the power of resistance towards storage rots, and what is more, their exposure in their impaired condition of 'health' to the favourable conditions for the development of bacteria and fungi which are ever present in bins, pits or the places of storage, should certainly be regarded as the most prominent factors responsible for the largest amount of losses occurring during storage.

What is necessary to start into action the myriads of fungus spores and bacteria present everywhere, and so destructive to stored vegetable matter of any kind? Is it not the moisture, warmth, absence of ventilation and light that encourage decay and rot, and are not these conditions fairly constant in all pits, bins, etc., where potatoes are stored? Besides the excellent food in the potato is ready prepared for the use of the ravenously feeding organisms of decay. Giving these lines a moment's thought and consideration, will the majority of readers not own that these very conditions prevail in their own cases? Have your potatoes been dug at the right time, were they quite ripe? Were none touched by frost or damaged by the digger? Is your cellar or pit well ventilated? If so, you have nothing to fear from storage rot, for then you are no doubt awake to the necessity of preventing late blight and other diseases. But those who must own up to one or more similar 'sins of omission' had better turn to their potatoes at once and start hand-picking them over, taking out all potatoes that show any of these signs.

The question is frequently asked by farmers sending samples of potatoes affected with storage rot, whether there is any treatment to prevent it from spoiling the potatoes. We are afraid there is nothing to be done to stop the decay once it has set in, beyond hand-picking them, removing all damaged, frozen or diseased potatoes, providing good ventilation and using for storage a cool place.

In the preceding lines we have spoken about the result to be expected from unripe, frozen or damaged potatoes, and have pointed out that, without being actually diseased, they are liable to suffer considerable losses. But how much more quickly will the decay set in when the tubers have been attacked by late blight and other diseases, eventually finding their way into the tuber.

There are a number of distinct parasitic diseases of the growing potato which will start a 'storage rot,' and which will spread by contact from diseased to sound tubers. Late blight (*Phytophthora infestans*) is the worst offender in this respect. The amount of late blight present in a field largely depends upon the successful and rapid control of the potato bug. When the potato bug has been allowed to gain a foothold, even if only for a short period, the vines are generally so much injured that it is almost impossible to keep the late blight from playing havoc.

In some potato experiments carried out at the Central Experimental Farm, with the view of producing potatoes as free from disease as possible under practical farming conditions, we secured from the four acres grown 1,770 bushels, which averages about 440 bushels per acre, by no means a light yield; but, notwithstanding careful spraying, the potato bug had done enough damage before it was controlled, so that late blight appeared and still caused far too much loss. Unless spraying is begun very early in the season late blight is difficult to control, and often about August and September the potato tops have been killed. Thus, not only is the manufacture of the reserve food to be stored in the tuber discontinued and the tubers remain unripe, but the disease spreads into the tubers. When this has taken place, the potatoes may be left in the ground for a week or so longer, when the rot will be more apparent, but when digging the potatoes, they should be hilled up on the field, covered lightly with straw and earth until they have dried up well. Before taking them in, the potatoes should be carefully hand-picked to remove all diseased or injured potatoes.

It is hardly necessary here to mention other diseases affecting the potato plant, for whatever their nature, as soon as the tubers become affected it amounts to the same thing, they must be picked out to prevent storage rot. Diseases like potato rosette or little potatoes (generally known as *rhizoctonia*), fusarium rot and others which may affect the potato tubers must be controlled or prevented by the use of good sound seed. When the potato tuber is once affected it is very liable to decay after being stored.

I have included in the term 'storage rot' the various forms known to the plant pathologist and caused by a number of different organisms. There are a number of different bacteria producing a soft or wet rot, and also scores of fungi, which find the prevailing conditions suitable for their growth and development, and produce dry rots and decay of various forms. Whatever form of rot may be developing in storage the prevention of losses will be the same in every case, and may be summarized in the following suggestions:—

1. Sound, ripe and undamaged potatoes will keep in this condition unless brought into contact with tubers showing signs of decay.

2. The prevention of losses in storage must begin in the field, where the growing plants should be regularly sprayed to prevent diseases likely to affect the tubers.

3. Potatoes should be dug when ripe if possible. Care should be exercised to prevent damaging tubers when digging. Frozen and damaged potatoes, as well as those showing signs of disease (with the exception of common scab) should not be placed in storage with sound ones, but must be carefully picked out.

4. Bins, pits, cellars should be cool, not above 40 degrees at any time, and good ventilation should be provided.

5. The stored tubers should be overhauled at intervals, and any potatoes showing signs of disease should be removed.

If the above suggestions are carried out not only will the losses in storage be wholly prevented, but the chances of carrying certain diseases over to next year, by the use of unsound tubers, will be eliminated.

EXPERIMENTS IN GROWING POTATOES

The Director of Experimental Farms instructed the Dominion Botanist to take charge of the growing of four leading varieties of potatoes on four acres of land, principally for the purpose of producing 'as large and as profitable a crop as possible; free from disease or as free from disease as possible under conditions such as exist in Canada to-day.'

The opportunity for demonstrating the effectiveness of spraying potatoes under field conditions was very welcome and after laying out the experiments, the first results are herewith reported. The practical work concerning planting, cultivation and harvesting was carried out under the direction of the Farm Foreman, Mr. D. D. Gray.

The plan of the experiment was briefly this:—

THE LAND.

Four statute acres of land in field E 1 of the Agriculturist's part of the Farm were used. The land was the year before under sod and had not been used for potatoes previously. Like all the land of the Central Farm, the soil varied in some parts, but was generally speaking fairly even and in suitable condition for potato growing. It was divided into four lots of one acre each, the dividing lines running east and west.

VARIETIES, QUANTITY USED, DATE OF PLANTING, ETC.

The following four varieties were chosen: Carman No. 1, Irish Cobbler, Gold Coin, and Early Delaware. Date of planting, May 31st. Planted by machine, single sets, 14 inches between sets, not more than five inches deep. Rows, partly 30, partly 32 inches apart.

SPRAYING FOR POTATO BEETLES AND DISEASES.

As soon as the plants were about six inches high, spraying was begun. A four-row double cylinder sprayer was used throughout the experiments. The four-row spraying attachment as sent out by the manufacturers did not give good satisfaction; the spray pump, however, was found very satisfactory. We have carefully studied the mechanics of this attachment and suggested a number of improvements to the manufacturers which they have agreed to carry out, and next year the new attachment will be used. The objections to the present attachment were that the nozzles could not possibly spray the plants from every side. Thus some rows were only half sprayed, and the potato beetles, which were present in countless numbers, fed ravenously on the unsprayed portions of the plants and did considerable damage.

The spray solutions used were:—

No. 1—6:4:40 Bordeaux mixture + 5 lbs. of Arsenate of lead.
No. 2—6:4:40 " " + 5 lbs. Arsenite of soda.
No. 3—5:5:40 " " + 5 lbs. Arsenate of lead.
No. 4—5:5:40 " " + 5 lbs. Arsenite of soda.

The spray solutions were carefully tested by the potassium ferro-cyanide method and thus every danger from deficiency of lime and leaf-burning in consequence removed. The spray rows run across the varieties so that each quarter of an acre of each variety received a different kind of spray.

Spraying began July 6th. It required 50 gallons of spray per acre, and took 2½ hours' time for the four acres. It was arranged to spray once a week, but, owing to incessant rain, the application had to be repeated at shorter intervals, the rain washing off the spray at various times. Up to the end of August, eight applications were given. In September the vines had grown so closely together that too much injury would have resulted from further sprayings. Blight appeared during the first week in September to some extent. On September 29th the vines were cut down by frost.

It was found that while both solutions (arsenate of lead and arsenite of soda) finally destroyed the potato beetles, their action was too slow to prevent a good deal of defoliation. Arsenate of lead adhered better and longer to the foliage.

The yield of potatoes was excellent, the quality fair and fairly sound, no scab, but a slight amount of late blight spots in tubers.

The following is the statement of yields per statute acre:—

Carman No. 1	444·31	bushels.
Early Delaware	471·33	"
Irish Cobbler	455:83	"
Gold Coin	411·48	"

No advantage of any one spray solution over the other could be observed.

Considerable quantities rotted in storage; insufficient ventilation and injury in digging were thought to account for this. The experiments will be continued for several years, when a more detailed account will be prepared.

AN EXPERIMENT WITH RHIZOCTONIA DISEASE OF POTATOES.

A rectangular area of land about $\frac{1}{10}$ acre in extent had the preceding year borne a crop of peas very badly affected with rhizoctonia. It was decided to see what results would accrue from the planting of this with potatoes and incidentally to try the effect of various treatments against this disease. One-half of the area was given a dressing of lime at the rate of three tons per acre early in the year, and the other half left untreated. Four varieties of potatoes were used, viz.:—Gold Coin. Carman No. 1, Empire State, Rochester Rose. The seed used showed both scab and rhizoctonia, and was treated as follows:—

(1) Check, untreated.
(2) Soaked in corrosive sublimate $\frac{1}{2000}$ for 3 hours.
(3) Dipped in gycerine (1:10 in water) and rolled in flowers of sulphur.
(4) Soaked ten minutes in 2 oz. lime-sulphur concentrate (Niagara Brand) to 6 quarts of water.

The land was laid out in thirty-two equal plots in such a way that the eight plots of each variety ran the whole length of the area, four being on the limed and four on the unlimed portion, while the tests in seed treatment extended across the four varieties and were duplicated on the limed and unlimed portions. Each plot was planted with sixty uncut tubers May 28th to May 30th. The plants were sprayed three times with arsenicals alone and then six times with Bordeaux mixture plus arsenicals, the season being exceedingly wet.

The plots were carefully watched during the season and records made, and finally the crop was lifted October 18th.

Careful examination of the crops showed that while there was considerable variation in the yield from the different plots, owing mainly to the variable quality of the soil, there were no constant differences between the plots differently treated in regard to seed or on limed or unlimed soil respectively. The only constant differences seemed to be in varietal freedom from and resistance to disease, Carman No. 1 being almost free from rhizoctonia on the tubers, Rochester Rose showing only a very little, and Empire State and Gold Coin showing little and a good deal respectively. In the standing crop no differences between the different varieties were observed in the matter of susceptibility to the disease.

POTATO SCAB EXPERIMENTS.

Another series of experiments carried on with a view to controlling the common scab of the potato were outlined and given in charge of my chief assistant, Mr. J. W. Eastham, B.Sc. who herewith reports the results in detail:

The problem of treating land infected with the organism of potato scab in such a way that the disease will be prevented or much reduced, has for many years engaged the attention of experimenters. So far, however, no method has been found for giving such a complete or partial sterilization to the soil, as would, at the same time, be applicable and remunerative under field conditions. In view, however, of the severe attacks of scab in many parts of the Dominion, and the frequency of inquiries regarding it, an experiment was undertaken to test one or two recommendations that have been made, and to try one or two substances not previously employed in this connection, although known to be of value in controlling certain other plant diseases. It seemed that the most promising substance in this category was chloride of lime (bleaching powder), a substance which, being manufactured on a large scale for use as a disinfectant, can be purchased comparatively cheaply (2c. per lb. in 400 lb. barrels). It has, moreover, given good results on a small scale in the treatment of Club Root, (*Plasmodiophora*) of Crucifers and certain other soil troubles. In the experiments mentioned, it was applied at the rate of half a pound to a square yard, either mixed with water or worked into the soil, which was then very liberally watered. The hypochlorite, which is the active component of the bleaching powder, rapidly undergoes chemical change with the production of substances harmless to plant life, and plants may be put into the treated ground two weeks or so after treatment. As the application of the substance in suspension or semi-solution in water, or even the copious watering of the ground after its application in the dry state, would involve an amount of labour prohibitive under field conditions in most cases, it was decided simply to mix the dry powder as thoroughly as possible with the surface soil.

Sawdust sown over the 'seed' in the drills at the rate of 5,000 lbs. per acre has been stated to be very successful in preventing scab (Experiments at Leeds University, Eng., quoted by J. B. Pole-Evans in Agr. Jour. S. Africa **1**: 692-3.) As sawdust is generally easy to procure, it was thought worth while to test its value.

As sulphur has also been found of value, it was decided to use it on one plot in the usual way, *i.e.*, in the form of a fine powder sown with the sets, and also in the form of concentrated lime-sulphur solution.

The land selected for the purpose of the experiment was located at Orwell, P.E.I. The soil was loamy, in a high state of cultivation and tolerably uniform in character over the area employed. Scab had been very severe in the potato crop raised on this land the preceding season, many tubers being completely covered with the excrescences and, in the words of the proprietor, bearing more resemblance to 'toads' than to potatoes. Scab is, moreover very bad in many parts of the district owing partly to the

extensive application of 'mussel mud,' a deposit highly calcareous from the presence of numerous shells and their remains.

A set of twelve plots was laid out, each 24 yds. by 10, and having an area of one-twentieth of an acre. They were laid out in two parallel series with a path 2 yds. wide between adjacent plots and 7 yds. wide between the two series. The variety of potatoes used was Carman No. 1. Sound seed was selected and treated with formalin solution, (1 lb. in 30 gallons of water) for two hours, except where otherwise stated. It was planted at the rate of 20 bushels per acre, *i.e.*, 1 bushel per plot. Soil treatment took place on the 24th and 25th of May, except when the substance was sown with the seed and planting took place on June 5. This gives an interval of only 12 days between the two operations. This might naturally be expected to exert an injurious influence on the crop, although it could hardly vitiate the results from the point of view of scab control. Certain other matters had unfortunately prevented the soil treatment from being carried out earlier as had been intended and it was not thought advisable to defer planting till after the date mentioned. No fertilizer was applied to any of the plots.

The following are the details of the individual plots:—

1. Check. Untreated soil planted with untreated very scabby tubers.
2. 250 lbs. sawdust (*i.e.*, 5,000 lbs. per acre) sown over sets in drills at time of planting.
3. 15 lbs. sulphur (*i.e.*, 300 lbs. per acre) sown like fertilizer during planting.
4. 12 gallons commercial lime-sulphur solution diluted with water to 40 gallons and applied to the surface of the soil by sprinkling cart May 24th.
5. 24 gallons commercial lime-sulphur solution diluted to 120 gallons applied similarly, May 24th.
6. Check. Sound seed treated two hours with 1 in 1,000 mercuric chloride (corrosive sublimate) solution. Soil untreated.
7. 50 lbs. chloride of lime, *i.e.*, 1,000 lbs. per acre. Applied May 25th.
8. 80 " " " 1,600 " " "
10. 120 " " " 2,400 " " "
12. 150 " " " 3,000 " " "
9. 200 " " " 4,000 " " "
11. Check. Soil untreated. Sound seed treated with formalin.

As chloride of lime is in the form of an exceedingly fine, dry powder, intensely irritating to the mucous membrane of the nose and throat, and also to the eyes, its application proved a somewhat disagreeable operation. It was found most convenient to use buckets, determine by weighing how much they would contain, and then fill them from the barrel. Water was sprinkled over the surface of the chloride in the bucket to prevent the wind from blowing it, and the bucket taken to the plot and emptied out on the ground. More water was at once sprinkled over it, and it was then mixed with soil and spread with a shovel. As soon as all the plots were thus dealt with the chloride was worked into the soil with a tooth-harrow. Very little rain occurred between treating and planting.

The crop was raised on September 20th, with the following result:—

Check Plot 6. Yield 7½ bushels. Exceedingly scabby, no clean tubers being found, and many tubers covered with scab. The amount of scab in this plot was taken for a standard of comparison as 100.

Check Plot 1. Yield 6½ bushels. Scabbiness about 80.

Check Plot 11. Yield 7½ bushels. Scabbiness 80.

Plot 3. Sulphur. Yield 8 bushels. Scabbiness 90.

4. Lime-sulphur. Yield 7 bushels. Scabbiness 45.

5. Lime-sulphur. Yield 5½ bushels. Scabbiness 35. Many tubers quite clean.

2. Sawdust. Foliage exceptionally green compared with other plots. Yield 7½ bushels. The sawdust was apparently in the same condition as when applied, no decomposition being visible. A few clean tubers, but most very scabby. Scabbiness 75.

7. Yield 4 bushels. Tubers small. Vines weak and spindly. Scabbiness 80.

8. Yield 3½ bushels, otherwise much like the last.

10. Yield 2 bushels. Scabbiness about the same.

12. Yield 2 bushels. Scabbiness about the same. Stand very uneven.

9. Yield ¾ bushel. Very few plants properly developed, and long bare spaces present in the rows where plants had not come up. Scabbiness over 80.

In examining these results, it will be noticed that the sawdust had little effect, the amount of scab being almost as high as on the best check plot. Presumably any beneficial effect it could have would be due to its decomposition, perhaps by its decomposition increasing the acidity of the soil, and therefore could hardly be looked for when so little alteration had taken place.

While no benefit was obtained from powdered sulphur there was a marked improvement where the soil was sprayed with lime-sulphur solution. The plot which received the double quantity showed rather less scab, but also a considerably diminished yield. As applied, the lime-sulphur was much diluted with water, which would, of course, increase the labour and cost of application, and no test was made with the undiluted substance, but even if the latter were just as effective, an application at the rate of 200 gallons or more per acre would be too expensive for ordinary purposes. There is also the objection that this result was obtained from a single experiment and might be due to a variation in the degree of infection of the soil or some other factor not accounted for, although, as far as could be judged, the conditions were uniform. The experiment at any rate would seem to be worth repeating.

With respect to chloride of lime, it is evident that even a comparatively small amount (200 lb. per acre) applied twelve days before planting exercised a markedly injurious action on the crop, while, on the other hand, when applied in such quantities as to render growth almost impossible, such tubers as are found are almost as badly scabbed as those on the check plots. It is, however, to be noted that little or no rain fell between the time of application of the chloride and that of planting. This would probably affect the results adversely in two ways. In the first place the germicidal constituent would not be so extensively and intimately diffused through the soil and therefore its effect on the scab organisms present would be restricted, and secondly its alteration into substances harmless to the crop would probably be slower. While the labour and cost of applying this substance in sufficient quantity in a state of suspension in water would seem to be prohibitive under field conditions, it would still seem to be necessary to try the effect of applications similar to those here given, made in the autumn instead of late spring, before concluding that it has no value in reducing scab.

It will be noticed that disinfection of the seed tubers whether with formalin or corrosive sublimate, produced no improvement in the scabbiness of the crop. This was naturally to be expected when the soil was so badly infected with the disease, but as this fact is, even now, not always recognized, it may not be amiss to call attention to it.

J. W. EASTHAM.

ERGOT.

Claviceps purpurea (Fr) Tul.

This fungus (together with one or two closely-related specimens which for our purpose need not be distinguished from it), is of importance to the agriculturist, not so much because it causes injury to the plants on which it grows, but because the resting bodies, or 'ergots,' contain substances highly injurious to the health of animals.

If a careful examination be made in late summer or fall of the ears of rye, wheat or barley, or of many grasses, *e.g.*,. couch, particularly if these are growing in damp situations, it may be noticed that in some of the florets the 'seed' is replaced by a spur-like or rounded, hard, purplish body, which is much larger than the grain would be, and consequently projects beyond the chaffy scales of the ear. These bodies are masses of resting mycelium (*sclerotia*) of the fungus and are known commonly as 'ergots.' In size they vary according to the plant on which they occur, reaching a length of an inch or more on rye and being very small on such a grass as red top *(Agrostis)*. Many species of grasses are liable to be attacked, whilst among cereals rye is most commonly affected, and to a less degree, wheat and barley. Unless harvested with the host plant, the sclerotia finally drop off and fall to the ground. Such of these as have been subjected to the right conditions undergo a new development in the following spring or early summer. From each, one to several rather stout stalks grow up into the air, reaching perhaps a length of an inch or more, each stalk terminating in a rounded purplish 'head' (*stroma*), whose surface is roughened with numerous small projections. These projections terminate in minute openings, each communicating with a separate chamber or cavity (*perithecium*) in the 'head.' At the base of each cavity is a dense tuft of elongated, somewhat club-shaped, spore-sacs (*asci*) in each of which eight threadlike spores are found. Ultimately these spores are liberated from the sacs enclosing them, and forced out through the opening of the *perithecium* into the air, to be dispersed by the wind. Should one of these spores be carried into the open flower of a susceptible grass or cereal and reach the ovary it is capable of producing a mycelium which develops in and around the ovary and which gives rise externally to large numbers of minute spores *(conidia)* together with a sweet, sticky liquid. The latter attracts certain insects to which the conidia adhere and are thus carried to other flowers. Each conidium is able to reproduce this stage of the disease, should it be brought into contact with the ovary of a susceptible plant at the right stage of development. This phase of the life-history of the fungus is so unlike the 'ergot' and the structures developed from it, that before the full life-history had been followed it was considered as belonging to a distinct species of fungus and given the generic name *Sphacelia*. It is still referred to as the Sphacelia or sphacelial stage. The mycelium, however, still continues to increase in quantity and becomes contracted, forming a mass replacing the ovary, but to the tip of which the withered-up stigmas and upper part of the ovary remain attached for some time. Conidia are no longer produced, and the outer layers of mycelium develop into a comparatively hard protective layer, the outer walls of which assume a dark purplish colour. This is now the sclerotium or 'ergot' stage similar to that with which we started.

The conditions which determine the germination of the sclerotia have not yet been fully determined, but apparently one very important factor is the degree of 'drying-out' to which they have been subjected. A completely dried-out sclerotium is commonly believed to be incapable of germination. Hence sclerotia a year or more old rarely germinate, while those kept even for a few months under ordinary warm con-

ditions appear to lose this power. This fact, no doubt, explains why, under natural conditions, ergot occurs to a much greater extent in low-lying, damp situations and in wet seasons. When the matter has been more fully investigated it may be found to have valuable practical results, since it may be possible to so treat seeds containing 'ergots' that the germinating power of these may be destroyed without injuring that of the seeds. In one of our experiments to test and study the germination of ergot that appeared in a barley plot on the Farm, the sclerotia were kept in a paper bag in the warm laboratory from harvest time (September) to May following. They were then placed in moist sand and not until October next could we observe signs of germination. The germination after this period of rest appears interesting in comparison with the above mentioned results of other investigators, who claim these grains do not germinate after completely drying-out. We also take this opportunity to place on record that we found the ascospores of this species to show three distinct septa, very prominent after careful staining. We do not know of any other record concerning this observation, which, however, is of scientific interest only. Ergot grains were submitted several times during the year and we collected some ourselves on rye, barley and wheat in the West.

As previously stated, the economic importance of ergot depends on the action upon the animal organism of certain chemical principles contained in the sclerotia. In large doses these produce contraction of the smaller blood vessels and also strong muscular contraction, which in the case of pregnant animals is liable to result in abortion. Taken for a period of time in smaller quantities the effects are very serious, among them being debility, muscular spasms and tremblings, gangrene, and the sloughing-off of portions of the extremities. Such results in the case of human beings are occasionally recorded over wide areas, where, as in parts of Continental Europe, rye-bread is an important article of food. On the other hand, various preparations of ergot find employment in medicine, its medicinal value for certain purposes being universally recognized.

Control Measures.—Seed containing ergots should not be sown, indeed the sale of such seed is an infringement of the Canadian Seed Control Act. Since only plants which are allowed to flower can become infected, it is important that the grass by road sides, etc., should be cut at intervals. If already infested with sclerotia it should be raked together when dry and burned. Since couch or twitch grass is very commonly affected, we have, in this fact, additional grounds for taking measures for the eradication of this weed. The roadsides all around Summerland, B.C., are overgrown with a tall sand grass (*Elymus condensatus*, Presl.) which we have observed to be considerably infected with ergot each year.

Where pastures have been found liable to extensive infection it would be well to cut the standing flowering-stems at intervals to prevent the development of sclerotia. Where these are already present, 'burning-over' when possible, will destroy many or most of them. It is advisable to remove stock from badly infested land, and hay or grain containing any considerable quantity of it should be destroyed rather than used for feeding purposes. The statement that ergot completely dried out has lost all vitality would be important, if true, as regards preventing its recurrence. Seed-wheat or other grain hardly suffers in vitality after two or three years' storage; in that time, no doubt, all ergot grains have lost their vitality.

BITTER PIT INVESTIGATION.

In previous reports attention has been called to the nature of this disease and its presence in Canada. In our report for last year, two papers by Dr. Jean White and Prof. A. J. Ewart, respectively, dealing with researches into this subject were noted, and it was also stated that the Commonwealth Government of Australia had taken up the matter and appointed Mr. D. McAlpine, the well-known pathologist, to devote himself

entirely to the investigation of this problem. Mr. McAlpine's first report on the work done now lies before us in the shape of a handsome quarto volume,* containg some 200 pages of text and descriptive letter press, and 35 plates with 133 illustrations of great excellence, mostly from original photographs. The work summarized included a detailed histological study of the Pome fruits, particularly with respect to the vascular system, the characteristics of the disease, a critical review of the literature on the history, distribution and hypotheses advanced in explanation of its occurrence, an analysis of the replies to a series of questions submitted to growers regarding more particularly the contributing factors, and an outline of experiments carried out and in progress. It is impossible to attempt in this place an adequate review of the phases of work taken up, but a few of the more interesting points may be noticed.

The form of the disease termed 'crinkle,' or confluent bitter pit, which is characterized by the surface of the fruit being thrown into rough folds with large cavities in the underlying tissues, is new to us, and according to the author has apparently been recorded outside of Australia only from California.

As regards the causes of the trouble, Mr. McAlpine considers that the evidence is entirely in favour of the hypothesis that it is due to irregularities in the factors influencing the balance between transpiration and water supply, and not to poisoning of cells, *e.g.*, by arsenical sprays. Both the recorded history of the disease and its presence on unsprayed trees are against the latter hypothesis. It was also found experimentally that fruit of an unsprayed tree protected from any possible contact with spray material from other parts of the orchard by being enclosed in calico bags as soon as the fruit had set was quite as badly affected as the exposed fruit of the same tree. The author sums up the matter of poisoning from the exterior as follows:—'After testing the effects of various chemical substances applied to the skin of the apple, I cannot emphasize it too strongly that all this production of external spots and smears has nothing to do with Bitter Pit. This disease originates from within and the action of an external agent on the skin is something totally different.'

The principal contributing factors are given as follows:—

'1. Intermittent weather conditions, when the fruit is at a critical period of growth.

'2. Amount and rapidity of transpiration.

'3. Sudden checking of the transpiration at night when the roots are still active owing to the heat of the soil.

'4. Failure of supplies at the periphery of the fruit followed by spasmodic and irregular recovery.

'5. Irregularity of growth, so that the vascular network controlling the distribution of nutritive material is not regularly formed.

'6. Fluctuations in temperature when fruit is in store, and

'7. Nature of variety.'

The question of storage conditions is particularly important since the disease usually develops to a large extent in storage. It was found, however, that 'even with very susceptible varieties the development of Bitter Pit was retarded by keeping them at an even temperature of 30° — 32° F.' It is recommended 'that the apples should be picked . . . . just when they have reached their full size, and on the green side, and placed in cold storage without delay.'

We congratulate Mr. McAlpine on the work he has already accomplished and shall look forward with increased interest for the results of his experiments directed towards the control of the trouble in the growing fruit.

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* Bitter Pit Investigation. The past history and present position of the Bitter Pit question, by D. McAlpine. First Progress Report 1911-12.

A 'STORAGE' SPOT OF THE APPLE.

Apples in storage are liable to a variety of maladies which often give serious trouble and result in much depreciation in value. A case of spotting of stored apples was brought to the notice of the Division during the year and investigated by Mr. Eastham who contributes the following account:—

In the Fall of 1912 a correspondent sent in some Gravenstein apples from North Sydney, N.S., affected by a peculiar spotting, with the enquiry whether this could be due to the use of arsenate of lead as an insecticide. Later, this correspondent sent apples similarly affected from his own orchard, together with the following statement:—

'The lime-sulphur I used was made by the Niagara Spray Co., Kentville, N.S., and tests almost 32.5B. Swift's arsenate of lead was also used, about 6 lbs. to 100 gallons. As far as I know all trees were sprayed in the same way. The weather conditions were noteworthy in this respect, that following a very hot spell for ten days the 1st of July we then for the next six weeks had one of the wettest seasons on record, and consequently a very great growth of Black Spot. Only the late sprayed and well sprayed orchards escaped. You will notice no Black Spot on sample sent. I have not noticed this injury on any other apple except the Gravenstein.

I first noticed the injury in Montreal at .... The manager had just opened some barrels of N. S. Gravensteins. He said the apples were not keeping well and he had put the price down 50 cents a barrel in consequence. I asked to see them and found the apples in the top of the barrel that had stood opened the day before as a sample, covered with this rusty injury. This did not extend to the fruit further down in the barrel, and on opening other barrels it was not found, but the manager said if exposed to the air they would show it in twenty-four hours. These apples were only just beginning to ripen. The injury did not appear on my own apples home for six weeks to two months afterwards.' It was also stated that six sprayings were given.

The spots varied in size from $\frac{1}{3}$ m.m. up to 5 m.m. in diameter, those of the latter size being circular, triangular or irregular. They were depressed, brown in colour. darkest in the centre round what, in many cases, appeared to be a lenticel. The smaller spots were by far the more numerous, as many as thirty-five being counted to the square centimeter but more commonly five to ten. In the case of the very smallest spots, the injury did not appear to go through the skin, the underlying tissue being sound. In the other spots, however, the underlying tissue was brown. The spots were much less plentiful and less conspicuous on the side of the apple exposed to the sun, being often hardly observable on the 'coloured' area. They seemed to be slightly more abundant at the calyx end. Where they were very numerous there was a tendency for the entire surface to show discolouration.

On December 3rd, after the apples had been placed in cold storage twenty-four hours, two similar ones were taken out and treated as follows: On one a circle 15 m.m. in diameter, was drawn in ink enclosing twenty spots, none more than half a m.m. in diameter. This apple was placed under a bell-jar and kept at the ordinary laboratory temperature which varied between 60° and 80° F. The other was similarly marked with a circle about 12 m.m. in diameter, and enclosing fifteen spots of a size similar to those of the first specimen. This apple was placed in cold storage. On December 23, none of the spots in the areas marked showed any appreciable enlargement in either of the apples. However, both apples by this time, but especially the one kept at room temperature, were badly rotted, although the rot had not extended into the areas marked. Whether the rot had started from similar spots as well as from bruises and abrasions could not be positively determined, although I think it likely.

Cultures were next made as follows: The apple was wiped, immersed for one minute in 1-1000 mercuric chloride and then rinsed in sterile water and

allowed to drain for a moment. Portions of the spotted skin were removed with sterile forceps, and the tissue underlying the spots transferred by means of sterile forceps or scalpel to Petri dishes. Tissue transfers were made from all sizes of spots from the smallest to the largest. In the former, as already mentioned, the discolouration did not always go through the skin and therefore some cultures were also made with portions of the spotted skin. One or two large spots which had been observed to be enlarging were also used, as they seemed to have started from the typical spots. Plates were poured with nutrient agar and 20 per cent potato agar. After six days the cultures taken from the enlarging spots showed a plentiful growth of mould (*Penicillium*). Those in which the skin of the apple had been used showed in some cases a growth of moulds; presumably the sterilization of the surface had not been complete. None of the other cultures, however, showed the presence of any organism nor did any develop later.

It seemed therefore from the non-enlargement of the spots when kept either at room temperatures or just above 0° C, together with the failure to develop organisms from them, that the cause was not a parasite. At the same time it seemed probable that saprophytic fungi could obtain entrance through these spots and set up rapid decay. Our correspondent evidently suspected arsenate of lead as a possible cause, and an account of a spotting of apples suspected to be due to this cause has been published. ('A new fruit spot of apple' by W. M. Scott, Phytopathology I., 32-34.) As compared with the spotting described by Scott, it would seem that the case under consideration differs in the much greater number of the spots, their small size and their absence from the 'blush' side instead of being concentrated there. If, however, the spotting is due to soluble arsenical compounds in the spray mixture, it is rather to be expected that the effect, as in this case, would be greater on the side away from the sun as evaporation would be slower and the chemical have a longer time to act. The spots being so small, a reliable comparative analysis of spotted and unspotted portions of the skin would have been somewhat difficult but an analysis of the skin as a whole, kindly made by the Dominion Chemist, Mr. Shutt, showed arsenic to be present to an average extent of ·00083 milligrams per apple.

It may seem at first sight that a spotting of the fruit which has developed in storage can hardly be due to the use of arsenical sprays applied when the fruit is not yet mature. It was shown, however, as stated, that arsenic was present on the skin of the apples when examined. It is possible, therefore, that the changes undergone by the apple in the process of after ripening may result as Waite* has suggested in the excretion of organic acids which have dissolved enough of the adherent arsenic to kill the adjacent cells. On the other hand Ewart** has shown that the pulp cells of an apple become increasingly sensitive to minute quantities of certain poisons as the fruit matures, and that the cells on the shaded side are more sensitive than those on the side exposed to the sun. He has, therefore, suggested the possibility of poisons being absorbed in minute quantities into the tissue of young apples but not producing any effect until the cells have been rendered more sensitive in the process of maturation.

At all events, while the cause of the spotting has not been demonstrated, it would seem to be of non-parasitic and external origin and to have much in common with the so-called 'Jonathan spot' which is suspected to be due to the use of arsenate of lead as an insecticide.

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* Quoted by W. H. Scott, *i.c.*

** Ewart, A. J., on Bitter Pit and the sensivity of apples to poisons. Proc. Roy. Soc. Victoria 24 (N.S.) Pt. II, 1911.

SYSTEMATIC BOTANY.

(F. Fyles, B.A.)

IDENTIFICATION OF PLANTS.

The numerous inquiries received year by year and the ever increasing number of plants sent in for classification, are sufficient evidence that the work of this branch of the Division is being appreciated by the general public. The number of specimens identified during the past fiscal year was four times that of the year ending March 31, 1910.

A large proportion of these specimens were plants of the woods in the spring and early summer, as it is very natural that such plants should attract attention. Many medicinal and poisonous plants were also received, with requests for information or literature regarding their identity and qualities. But the greater part of them consisted of weeds sent in by farmers seeking advice as to the best methods for their eradication.

WEEDS.

Those weeds most frequently sent in were:—Canada Fleabane, Sow Thistles, Field Cress, Toadflax, Orange Hawkweed, Campions, Couch-grass, Biennial Wormwood, Barnyard Grass and Cinquefoil.

The Prairie Cone-flower (*Lepachys columnaris* (Sims) T. and G.) and the Western Gum Weed (*Grindelia squarrosa* (Pursh) Dunal.), were reported from Toronto. Although this is not the first time that the latter has been found in Ontario, it is well to point out that these undesirable weeds are spreading. No doubt their increase is largely due to the transportation of commercial seeds. Such was the case in the appearance of *Bromus arvensis* L. (Field Brome Grass) and *Polypogon monspeliensis* (L.) Desf. (Beard Grass) at St. Thomas, Ont., and in regard to *Tussilago Farfara* L. (Coltsfoot) reported from St. John, N.B.

A WEED NEW TO CANADA.

The Thorny Amaranth (*Amaranthus spinosus* L.)

The Thorny Amaranth, which as far as we know, made its first appearance in Canada at St. Thomas, Ontario, last summer, is a coarse annual plant belonging to the Pigweed Family (*Amaranthaceæ*). It is a native of tropical America and has become naturalized in the north-eastern United States, where it has caused considerable damage. Like its allied species, Red-root Pigweed (*Amaranthus retroflexus* L.) and Tumble-weed (*A. græcizans* L.), the Thorny Amaranth produces annually a large quantity of small, black, highly polished, lens-shaped seeds, and by this means of propagation spreads rapidly. The plant, which grows to a height of three feet or more, is very bushy in general appearance, often having as many as six stout branches from the base of the stem, varying in diameter from one-half to three-quarters of an inch. Being of rank and succulent growth, it deprives useful plants in its proximity of necessary moisture and nourishment. Farmers are advised to make a point of destroying this weed on its first appearance. It is easily distinguished from the other species of Pigweed by the rigid spines at the base of each leaf-stalk. These measure from one-

quarter to one-half an inch in length. (See illustration, plate XXI, fig. 1.) The Thorny Amaranth, like the Russian Thistle and other plants possessing sharp spines, is likely to cause much irritation to horses and to labourers working in the fields. When cut and dried with the hay and afterwards eaten by cattle and horses, the spines penetrate the mucous membrane and may cause serious inflammation.

Acroptilon Picris DC.

The bright white seeds found in Turkestan alfalfa, which have been identified as *Acroptilon picris* DC., and of which there is a short description in Bulletin S6, issued by the Seed Branch, are familiar to all seed merchants and others handling Turkestan alfalfa. But it is not so well known that this seed will produce a vigorous perennial plant, capable of withstanding the winters at Ottawa. The plant produces a long, horizontal, underground rootstock which sends up new shoots at each node. From six to ten new plants are produced by the parent plant in this manner. The stem and leaves are covered with a hoary pubescence, which gives to the plant a dull whitish-green colour. The lower leaves are long, narrow and deeply pinnatifid. The upper leaves are more sparingly and less deeply cut.

Hieracium aurantiacum L. (Orange Hawkweed) and Allied Species.

On the 27th of June, 1912, there was issued by this Division, a circular on 'Orange Hawkweed.' This circular was printed in the form of a card with a coloured illustration of the weed. A brief account of the life history of the weed, together with the best methods for its eradication, was printed in large type on the card. Forty thousand copies of these cards were published and distributed, chiefly in the Province of Quebec, where the weed is most prevalent. The difficulty of eradicating this pest may be overcome with the co-operation of the farmers. Most farmers will agree that is more readily destroyed than Couch or Twitch Grass. Paint-brush will not long exist on well cultivated and well fertilized land. Shallow ploughing, harrowing and thorough cultivation repeatedly practised throughout the autumn, followed by a rotation of crops into which hoed crops largely enter, will keep it under control. The weed thrives best on poor land and in rocky pastures which cannot be cultivated. In this case sheep will eat it close to the ground. There is no portion of Canada better suited to sheep-raising than the hilly sections of the Eastern Townships. Salt, if applied in hot, dry weather, is another sure means of killing it.

The bright red-orange flowers of this species are easily distinguished from the yellow flowers of the Many-flowered Hawkweed, and the King Devils which, although not so abundant, are, in themselves, none the less troublesome. The many-flowered Hawkweed (*H. floribundum* Wimm. and Grab.) produces leafy secondary flowering shoots as well as stolons or runners. The King Devils (*H. pratense, H. praealtum* var. *decipiens*) are of similar growth, that is, they are reproduced both by runners and seeds. The same method of treatment as recommended in the case of *H. aurantiacum* will exterminate these.

The Mouse-ear Hawkweed (*H. Pilosella* L.), which is a troublesome weed on lawns, is a shorter and smaller species. It bears a solitary, pale yellow flower somewhat resembling a small dandelion, but the close mat of small, entire leaves at the base of the flowering stalk as well as its runners, proclaim it to be a Hawkweed. Several patches of this weed in the arboretum were entirely destroyed by a single application of coarse salt.

The following weeds were sprayed with a solution of iron sulphate, 2 lb. per gallon of water:—Ox-eye Daisy, Field Bindweed, Heal-all, Dandelion and Sedum. After the third application these weeds were still living, although much of the foliage was destroyed. As the injury to the surrounding grass was greater than that to the weeds, the spraying was discontinued.

BOTANIC GARDENS.

The labelling of the native trees and shrubs in the Arboretum has been completed, and the task of re-naming and re-labelling the indigenous herbaceous perennials has been begun, fifty-two different species being already designated by the new labels with names according to Engler and Prantl—the nomenclature adopted in Gray's New Manual of Botany, the standard manual of students. This work will be particularly valuable to teachers and students, who frequently visit the gardens to study rare species and species from distant parts of Canada, which otherwise it might be impossible to examine except from dried material.

An alphabetical list of all the plants in the North and South borders was compiled with the corresponding numbers of the row and square in which each plant is to be found. It is hoped that in time a similar list may be made of the trees and shrubs.

SEED EXCHANGE.

In the summer and autumn of 1912, 433 different species of seeds were collected in the Arboretum and Botanic Garden. A list of these seeds was sent to different parts of the world, preferably to those Botanic Gardens in climates similar to our own. On request, we sent out 385 different species, and received 351 in return.

DRUG PLANTS.

As our correspondence increases, the interest in the cultivation of certain drug plants in Canada becomes more evident.

Although the cultivation of drug plants is certainly an interesting undertaking and may be a profitable one under favourable conditions, it is necessary to point out that, before entering upon any extensive work in this direction, the expenses entailed should be carefully considered. As long as the price of land and the cost of efficient labour continue to be so high, it is doubtful whether, from a commercial standpoint, it will prove successful in Canada.

Since we are frequently requested to supply information in regard to Golden Seal, the following account of it will be of service.

GOLDEN SEAL *(Hydrastis canadensis L.).*

Hydrastis canadensis L., commonly known as Golden Seal, is a low perennial herb belonging to the Buttercup family (Ranunculaceæ). It is found growing wild in rich woods in the western peninsula of Ontario. It has a thick and knotted yellow rootstock, which sends up in the early spring one radical leaf, and a simple hairy stem with two leaves near the summit, and an inconspicuous, solitary, greenish-white flower. When in bloom the plant is about twelve inches high. The leaves have not at that time reached their full expansion. At maturity they measure six to eight inches across. They are palmately 5-7 lobel, with toothed margins. The flower, which opens during the month of May, lasts but a short time. It has no petals but three sepals which soon drop off, leaving the numerous stamens and the pistils unprotected. The fruit matures in July or August. The head of small scarlet berries somewhat resembles a raspberry. The rootstock is marked by seal-like impressions made by the shoots of the previous years. These scars and its bright yellow colour have obtained for it the name of 'Golden Seal.'

Both the yellow roots and rootstock contain the valuable drug known on the market as 'hydrastin.' They are carefully washed and thoroughly dried before they are sent to market. They lose their colour and become inferior in quality with age.

Hydrastis is easily cultivated. Any good garden soil into which leaf mould has been well worked, and a shady situation will answer its requirements. It has been successfully grown on a small scale in the shade of a row of shrubs and trees in our Botanic Garden. When it is grown for commercial purposes it is better to give it artificial shade by a framework of lath such as is used in the cultivation of Ginseng.

Golden Seal is sometimes confused with Gold Thread (*Coptis trifolia* (L.) Salisb.), another perennial of the woods belonging to the same family. But, as the rootstock of Golden Seal is short, thick and knotted and that of the Gold Thread is long, slender and smooth, they are easily distinguished by these points alone, apart from other dissimilarities of growth. (See illustration Plate XXI, Figs. 2 and 3). The rootstock of Gold Thread extends horizontally near the surface of the soil thus making its deep, yellow colour conspicuous. Although Gold Thread is very bitter, it is not unpleasant and has no odour, while Golden Seal has a distinctly disagreeable odour and an unpleasantly bitter taste.

Seed Collection and Herbarium.

The seed collection and the herbarium have been added to from time to time as opportunity permitted. About 500 specimen sheets were added during the year. Specimens of the Painted Trillium (*Trillium undulatum* Willd.) were brought from Prince Edward Island, which is a new locality for this rather rare species.

Several different kinds of seeds and plants of particular interest in the seed collection and greenhouse were brought from Bermuda.

Drawn by F. Fyles.

Fig. 1—Thorny Amaranth. Fih. 3—Golden Thread.
Fig. 2—Golden Seal. Fig. 4—Golden Seal in flower.

(Half natural size).

FIRST REPORT FROM THE BRANCH LABORATORY OF THE DIVISION OF BOTANY, ST. CATHARINES, ONT.

BY

W. A. McCUBBIN, M.A., assistant in charge of Field Laboratory of Plant Pathology, St. Catharines, Ont.

This laboratory was established by the Division of Botany for the study of plant diseases in the Niagara District and was opened August 1, 1912.

In the beginning of this year's work, some time was necessarily consumed in fitting up the building, apparatus, and supplies, and in becoming acquainted with the conditions in the neighbourhood. For this purpose the greater part of the Niagara peninsula was visited, and every opportunity taken, of laying before the fruit-growers and farmers the purposes of the station and endeavouring to enlist their co-operation. Advantage was taken of meetings held in Grimsby, McNab, Queenston and Louth Township, by Mr. Caesar of Guelph, for demonstrating the symptoms of 'Yellows,' and 'Little Peach,' and at each of these the aims and objects of the Station were presented in a short address.

Throughout the season, a study of local diseases was carried on as fully as possible. Collections of over one hundred specimens of various diseases were made and numerous observations recorded for reference and for future experiments. An exhibit of some of the commoner and more destructive of these diseases was set up at the St. Catharines Horticultural Show in September.

Owing to the lateness of the season, experimental work was necessarily limited, but several experiments were begun, the results of which will not be apparent till next summer at earliest.

A large number of peach cankers were treated in various ways and with different materials in order to find out a cheap, simple, and effective method of dealing with this trouble, which has become quite a nuisance in several orchards here.

The currant polyporus (*Pyropolyporus ribis*), found in quite large numbers in one field, was treated with several fungicides. As far as can be ascertained as yet, formalin, copper sulphate, salt and ashes are effective in killing this fungus, which, though not common, seems to be serious enough once it infests a field.

Considerable attention was given to the 'mosaic' disease of tomatoes, which appeared in many places in this region during the summer. Certain features about the cases seen here tend to locate the trouble in the soil. Seeds of affected plants were collected and will be grown next year to make certain that, as has been claimed, the disease is not transmitted through the seed.

A series of experiments on the treatment of Yellows and Little Peach, begun last year by the Dominion Botanist, were carried on more fully this year. Conclusive results from these experiments cannot be looked for for another year at least.

About 2,000 peach stones from trees affected by Little Peach were collected, and will be planted next year to determine the germinating capacity. This work is done jointly with Mr. Caesar, Provincial Entomologist and Pathologist.

As raspberry cane blight is rather prevalent and destructive in some parts of the district, an experiment was begun on the control of this disease by spraying. All the dead and diseased canes were removed and late in the autumn the field was sprayed with Bordeaux. This spraying will be continued next spring.

A fatal case of mushroom poisoning in the city of St. Catharines and reports of several others in the vicinity led to the investigation of the cause. There appears to be an exceptionally large number of the very poisonous *Amanita phalloides* in all the surrounding woods, and this is sometimes mistaken for the edible *Lepiota naucina*, also very abundant. In order to point out the distinguishing features of these, an exhibit of them, along with other edible and poisonous fungi, was placed in a shop window with very satisfactory results.

All the meetings of the Local Fruit-Growers' Association in December and March were attended, and at each a short address was given, setting forth the work the Station purposes to carry on, and dealing with some diseases of timely interest. An address was also given in November to the Teachers' Convention at St. Catharines on the nature of plant diseases and their treatment.

W. A. McCUBBIN,
Assistant in Plant Pathology.

DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARM

REPORT

FROM THE

DIVISION OF BOTANY

FOR THE

Fiscal Year Ending March, 31, 1914

PREPARED BY

The Dominion Botanist. . . . . H. T. Güssow.

REPORT OF THE DIVISION OF BOTANY.

(H. T. GÜSSOW, DOMINION BOTANIST.)

OTTAWA, March 31, 1914.

J. H. GRISDALE, Esq., B. Agr.,
Director, Experimental Farms,
Department of Agriculture, Ottawa.

SIR,—I have the honour to submit herewith my fifth annual report of the work carried on in the Division under my charge. Attached to this main report is a report from the Plant Pathological Branch Laboratory in St. Catharines in charge of Mr. W. A. McCubbin, M.A. The work of the Division, particularly that of advising farmers, fruit-growers, and others is increasing considerably, and much of the time of my staff is occupied by attention to these requests for information. However, some original investigations have been carried out, but it is realized that there are a considerable number of specific diseases and investigations along other botanical lines which will make an increase of the staff and laboratory accommodation most necessary in the near future.

Another feature of the work is the administration of the Destructive Insect and Pest Act, as far as plant diseases are concerned; owing to the prominence which the potato has received in this respect during the year my own time and that of several members of my staff has been occupied thereby to a great extent, and in consequence many important lines of research work had necessarily to be curtailed. For convenience sake the report is divided into the following sections, in which the more important work done by this Division is referred to in detail:—

I. Plant Pathology.
   (a) Destructive Insect and Pest Act.
   (b) Investigation of specific diseases.

II. Experimental work.
III. Economic Botany.
IV. Miscellaneous.
V. Report of St. Catharines Laboratory.

I. PLANT PATHOLOGY.

(a) ADMINISTRATION OF DESTRUCTIVE INSECT AND PEST ACT.

Diseases of plants may cause considerable economic losses by direct destruction of cultivated plants, but may also, if prevailing in one country or continent, result in the exclusion of a particular kind of vegetation from export into another country that may be found free from any such disease. Losses from diseases likely to be imported from other countries are guarded against by certain measures restricting importation or prohibiting it altogether from countries in which such diseases may prevail. This attitude is most correct, and different nations as well as parts of the British Empire are more generally adopting legislative measures for the control of

plant diseases. When, however, by reason of a disease a country is barred from further export of the vegetation concerned, this is another serious aspect of the "losses" caused by diseases of plants.

These measures should have a decided beneficial result inasmuch as they would compel or encourage a country under embargo to fight the disease in the most effective way in order to regain the market in the country that has placed such an embargo.

The Dominion of Canada felt it advisable to enforce such an embargo on potatoes grown in countries in which Potato Canker prevails. As soon as the countries affected by this measure are in a position to prove that they have successfully combatted Potato Canker, or are in a position to guarantee that no potatoes affected by such disease will be exported, this embargo will be removed, as it is not the intention of such protective measures to interfere with the commercial relations of two countries.

However, the Dominion of Canada during the time which is covered by this report experienced the effects of such embargo, which was placed upon Canadian potatoes by the United States for reason of a disease now well known to the farmer by the name of Powdery Scab. A public meeting was held in Washington on December 18, before the United States Federal Board of Horticulture to hear from interested parties why an embargo should not be laid. The Dominion Botanist was instructed to represent the department as technical expert. The United States authorities, however, decided to place an embargo until such times as would assure freedom from disease in imported potatoes.

The presence of Powdery Scab in Canada resulted in the loss of the American market, which was greatly lamented by growers in the eastern provinces. This disease has only been discovered in Canada in the fall of 1912; whether this disease has been long in this country or whether it is a serious disease does not concern us here, but owing to its presence in Canada farmers were not permitted to sell their potatoes in the States.

To eastern farmers, particularly those in New Brunswick, Quebec, Nova Scotia, and Prince Edward Island, this embargo is a very unwelcome measure, more so apparently than the disease itself. This is the wrong attitude to take, seeing that the disease causes as much damage to our own potato industry as it is thought it will do in the United States, but one fact is absolutely clear—the United States will be ready to admit the Canadian crop as soon as we have cleared our fields of this disease.

The Division caused detailed information on the appearance of this disease to be widely distributed, and every farmer who has seen a copy of the publication will find that the prevention and extermination of this disease—like any other disease—rests exclusively with himself. The directions are briefly these:—

First.—Use clean seed that is absolutely free from powdery scab, and preferably free from any kind of tuber disease.

Second.—Plant clean seed on land that has never borne a crop of potatoes before, or at any rate not a crop that has been diseased.

Third.—Avoid all contact with diseased potatoes, infected implements, bags, cellars, etc.

A crop grown from pure and sound seed, raised on land that is not infected, and that is found on inspection free from disease will gladly be accepted by the United States. It is hoped that all farmers in the Dominion will follow these instructions; the disease will then disappear and the market of the world be open again. When it is fully realized that these are the only means to check and eradicate the disease, and to re-establish the trade, it is hoped that the embargo will soon be lifted.

Detailed information about this disease is contained in Farmers' Circulars No. 4 and No. 5, which may be obtained by those who have not already received a copy by applying to the Publication Branch, Department of Agriculture, Ottawa.

OTTAWA.

This Division has endeavoured to carry out a widespread campaign with the object of securing the farmers' co-operation in eradicating this disease. Inspectors have been busy all over the provinces concerned, and a seed potato inspection has also been carried on as far as practicable. The future will show us whether the farmers have co-operated with us and can show a clean crop of potatoes this fall.

(b) Investigation of Specific Diseases.

Need for Specialization in the Investigation of Plant Diseases.

The investigation of diseases of plants includes the study of the cause and life-history of the causal organism, but is principally undertaken for the purpose of finding a cure or prevention of the disease. Investigations of this kind often require years to reach satisfactory conclusions. Some diseases have puzzled investigators for many years, and yet we are no nearer to the solution of some problems than we were when the disease was first taken up for study. Peach Yellows, Little Peach, Bitter Pit, Mosaic diseases, Leaf curls, etc., are examples of this type. Some of these diseases were known many years, the loss they cause even to-day is considerable, but nothing definite is known about their control.

There is most urgent need for more specialized study of the various diseases as they affect the different plants of economic value.

It was recently shown that the Dominion of Canada loses annually a sum of nearly $17,000,000 from smut diseases affecting wheat, oats, and barley. The grain rust causes probably a much greater loss. Obscure grain diseases are being reported from southern Alberta, hence it is most necessary to devote special attention to grain diseases. It is hoped that such work may be commenced at an early date, when it is intended to place a field laboratory in one of the western provinces in charge of an officer who will devote his time exclusively to the study of these diseases and the question of rust resistance.

VALUE OF FIELD STATIONS.

From the report of the officer in charge of the plant pathological laboratory in St. Catharines, which is a branch of this laboratory, it will be seen that considerable advance has been made in a comparatively short time, owing to the fact that this laboratory is situated in one of the most important fruit-growing centres of Ontario, affording a splendid opportunity for the study of fruit diseases. The officer is in close touch with the growers, is right on the spot to give advice and to demonstrate the methods of control and devote his time to the study of the diseases in the orchards, instead of endeavouring to experiment on vegetation not growing under the climatic or cultural conditions existing in the locality where the disease occurred.

It is felt that from the establishment of field stations in different parts of the Dominion, valuable results may be expected, and it is the intention of the Minister of Agriculture to afford every assistance for the extension of this work.

STUDENTS AND PLANT PATHOLOGY.

Students at agricultural colleges and the universities are advised to devote their special attention to plant pathological science, the future of which, it is reasonable to state, is most promising in the Dominion. At the present moment difficulties are experienced in securing the services of young Canadians who possess such special knowledge.

CONCERNING SENDING OF PLANT-DISEASE SPECIMENS.

During all parts of the year, but naturally more during the period of growth, the officers are kept busy answering the many inquiries and examining specimens of diseases

received from farmers or fruit-growers. Much time would be saved if more care were taken in packing the specimens so that they would arrive in better condition. The condition of some specimens is so bad that no result can be gained from an examination. Samples of diseased roots should be free from soil, which should be shaken but not washed off. Leaves and like specimens might be wrapped with rhubarb or cabbage leaves, when they will arrive in a fresh condition. It is of no use to send putrid matter —no advice can be given on specimens not in a fit condition for examination. The sending of good specimens showing the disease and its progress from the earliest stages to the more advanced is particularly requested. In the case of bacterial troubles, which spread very rapidly, this attention is most important.

DISEASES FURTHER STUDIED OR RECENTLY OBSERVED.

Potato Diseases.

Powdery Scab.—Reference has already been made to Powdery Scab, on the subject of which Circular No. 5, prepared by Mr. J. W. Eastham, has been published.

Common Scab.—A study of the organism of Common Scab has been commenced, which led to various new phases of research. The organism hitherto referred to as *Oospora scabies* Thaxter was originally, but provisionally, described by Prof. Roland Thaxter. After isolating the organism from tubers grown on the Central Farm, it was carefully studied, when it was found that it properly belongs to a group of bacteria known as sheath bacteria (*Chlamydobacteriaceae*), viz., *Actinomyces*. This genus commonly occurs in the soil and it will be found most important to carefully study these organisms with a view to the determination of their parasitism towards plants and animals. One species (*A. bovis*) causes the well-known "lump jaw" in cattle. We have also observed one species that occurred in milk. The disease "*Actinomycosis*" is known to have been found in the udder of cows, and the causal organism may then be found in milk of diseased cows. This germ also occurs in the air, water, on hay, and pasture herbage. Prof. F. Lafar in his "Handbuch" points out that frequently serious cases of disease have been observed, which apparently originated from the use of straws and grass haulms as "toothpicks"—by no means an uncommon peculiarity of persons walking through a field—which practice has resulted in the development of "*Actinomycosis*" a disease painful at any rate, if not fatal, which it may be once it reaches the lungs or respiratory organs. It is a fact which we have often observed that *Actinomyces* may be isolated from herbage, particularly of the order of grasses. The researches into the nature and relationship of these organisms now being conducted in this laboratory may reveal interesting facts.

Silver Scurf (See plate).—Of the potatoes sent in for examination from several provinces during the past winter quite a large number were affected with this disease. It is confined to the skin of the potato tuber and makes its appearance as ashy-grey spots on the surface. These become larger as time goes on, and several spots may become confluent, thus covering a large area of the tuber. The outer layers of the skin are killed by the fungus and take on a different colour from the healthy skin. Owing to the silvery sheen of the dead skin, and to the fact that it dries up and peels off readily, the disease has been given the appropriate name of "Silver Scurf." In many cases there is present, in addition, on the surface of these silvery spots, small black specks which are just visible to the naked eye. These are the "sclerotia" of the fungus, that is, each consists of a dense mass of closely interwoven fungus filaments, and by means of these the disease is reproduced.

If a tuber affected with Silver Scurf be washed and kept fairly moist for a few days the surface of the silvered spot appears as though a very thin layer of soot were dusted over it. This dark powder on examination under the microscope is seen to consist of the spores of the fungus. The fungal filaments running through the skin

of the silvered spot or those forming the sclerotium grow out from the surface of the tuber and bear the spores in groups along them, being more or less treelike in appearance. Each spore is of a dark-brown colour and consists of a row of cells. If placed in water during the summer months the spores germinate readily inside two days, and form a germ-tube several times the length of the spore itself. When tubers showing Silver Scurf are planted in the ground, doubtless spores are formed and germinate in a similar manner, and in this way the infection probably spreads to the next crop of potatoes.

The tree-like spore-bearing stage of this fungus was described by Harz as *Spondylocladium atrovirens*, while the sclerotium form was described by Frank as *Phellomyces sclerotiophorus*. Later, Appel and Laubert showed that they were both different stages of the same fungus, consequently the former name is the one by which the fungus is now known.

Orton, in Farmers' Bulletin No. 544 of the United States Department of Agriculture, published in 1913, states that the disease has recently been introduced from Europe and is spreading rapidly in the Eastern States. Melhus, in Circular No. 127, Bureau of Plant Industry, dated 1913, says that the fungus is not killed by seed disinfection with formalin or corrosive sublimate. On the other hand, Johnson, of Dublin, found that soaking the tubers for one hour in a solution of formalin of rather less than one per cent strength was an effective remedy.

Experiments showing the results of steeping affected tubers in various fungicides are being carried out at the Central Experimental Farm, but the results will not be available until the autumn of the year 1914. In the meantime, farmers would be wise to reject seed-tubers affected with this malady. Although the disease has not up to the present been regarded as a very serious one, still as it kills the outer cells of the skin of the tuber, and as these outer cells are the most important part of the skin in preventing the entrance of fungal diseases, it is just possible that it may prepare the way for other more serious maladies.

The accompanying plate shows the external appearance of the disease on the surface of the potato tuber.

"Black Heart" of Potatoes (See plate I).—Mr. E. T. Bartholomew, in Phytopathology *III*, p. 180 describes and figures a blackish discolouration in the centre of potatoes which is quite different from the "sprain" or "internal brown streak" or the "rusty spots" which are being observed from time to time. He publishes a preliminary note in which he states that this often purplish to inky-black spot, at times showing a central cavity, may be produced in potatoes that have been stored during winter by keeping them for a certain period of time in a temperature of about 40° C. (104½ F.).

We have had occasion to observe the identical trouble this spring. For experimental purposes, the following varieties were stored in a "pit" above ground at some rather exposed place at the Central Farm on November 1, 1913: Irish Cobbler, Gold Coin, Early Delaware, Carman No. 1. The outside temperature went down to some 30° F. below zero. The temperature of the pit was taken daily by a self-registering thermometer. During no time was the temperature recorded below 32·5° or above 46·5° F. Thermometer and recorder were both reliable.

The same varieties of potatoes were stored in the farm root-house where at no time did the temperature rise above 45° F. or go down to freezing.

A third lot was stored in the cellar of a heated barn where the temperature went little above 42°F.

Good ventilation existed in all three places of storage.

In April, 1914, the pit was opened and showed that frost had no doubt invaded the pit, the upper layer of potatoes showed plain signs of the wet and pulpy spots due

to frost. It must be remembered that the thermometer went to about the centre of the pit in a wooden tube.

When it was noticed that frost had to some extent touched the stored potatoes, a number of tubers were cut while they were being removed, when it was found that Delaware showed 20 per cent, Irish Cobbler 10 per cent, Gold Coin 30 per cent, and Carman No. 1 20 per cent of the tubers with the characteristic radiating central discoloration. In some instances we observed a certain pinkish coloration in the centre of a good many potatoes, but they did not show the typical black heart. On exposure to air these portions turned reddish and then blackish, but were not very clearly defined in outline owing to the turning dark of the cut surface which always occurs on exposure to air. After they were taken from the pit these tubers were stored about two weeks in the root-house where the others had been stored over winter. Another examination was then made. From each of the four varieties about twenty-five tubers were taken, without any selection; on cutting them in halves 90 per cent of them showed the typical black heart. We then examined a similar quantity of the same varieties which had been stored since harvest in the root-house. In no single instance did any such discoloration appear when cutting the tubers of the same varieties grown on the same field and harvested under the same conditions. The only difference of treatment was in the storing, those wintered in the pit showing 90 per cent black heart, and those in the root-house with none at all affected. In this connection it is interesting to note that according to Bartholomew a comparatively high temperature of 104° F. will result in what is apparently the same thing as occurred with us, and which we feel disposed to regard as frost injury.

The appearance presented by these potatoes taken from the pit is shown in the accompanying plate.

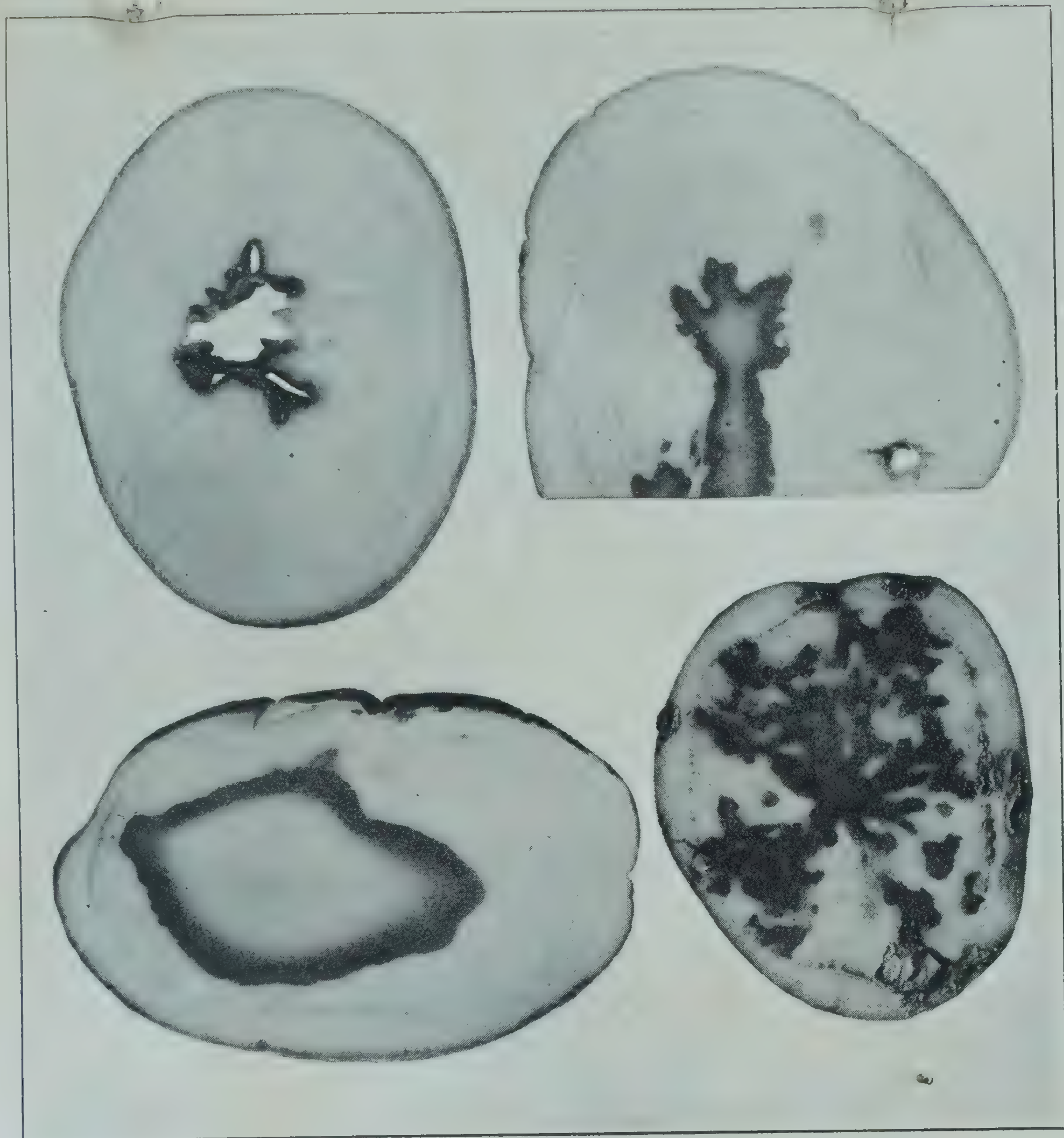
Potato diseases transmitted by the use of unsound seed potatoes.—Attention is called here to the publication of a folder showing the principal potato diseases resulting from the use of unsound potatoes for seed. This folder shows the various diseases in natural colours, which should enable every farmer to determine at once which diseases to avoid when preparing for planting. The drawings have been executed under the Dominion Botanist's direction by Mr. A. E. Kellett, an officer of the Division of Entomology, who deserves much credit for the artistic skill with which he has prepared them. This publication was printed in an edition of 125,000 copies in English and 40,000 copies in French, and was very widely distributed. Farmers are most earnestly requested to follow the instructions in this special circular, when it is reasonable to hope that potato diseases will soon decrease in virulence. It cannot be said too often that the potato grower is the only person who is in a position to produce a crop which is free from disease. And, naturally, disease-free potatoes will find a much more ready sale than diseased ones which are a menace to the whole country.

DISEASES OF FRUIT TREES.

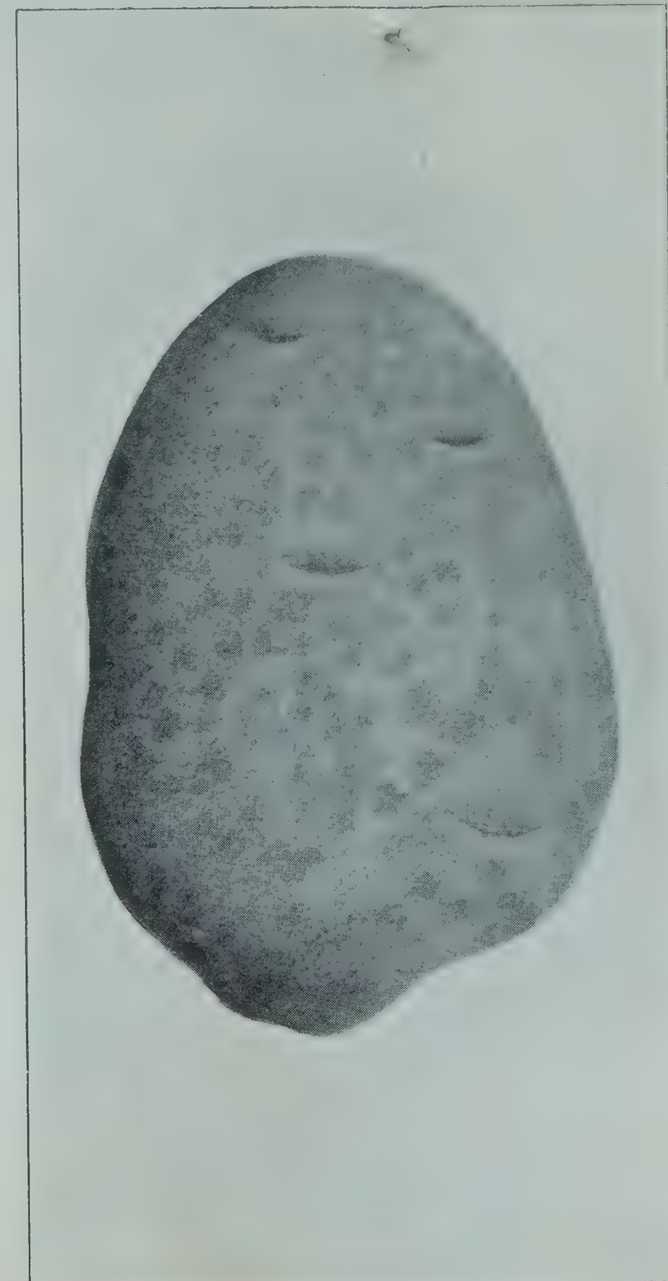
Apple Canker.—(The following notes on Apple Canker were supplied by Mr. J. W. Eastham, B. Sc.):

"About the middle of July, I made an inspection of a number of orchards in the vicinity of Fredericton, N.B., with a view to ascertaining if any injury were being done to apple trees in this vicinity by the *Nectria ditissima* canker. Although a number of very neglected orchards were visited, many of the trees in which were dying back and in which spraying was never practised, no *Nectria ditissima* was found.

"I then proceeded to the Annapolis valley, commencing at the Digby end. Around Digby a few cankers were noticed, but I did not find any orchards here of any size. Around Bridgetown and Annapolis Royal there were a large number of neglected orchards, and in these cankers were found in abundance. In some cases in young



Injury due to frost penetrating potato pit.



"Silver Scurf," a disease causing a silvery sheen on surface of potatoes.

orchards it seemed likely that a goodly number of trees would be girdled and killed. but in most cases it seemed as though a branch might continue to fruit for many years after being invaded, cankers being found with successive annual growths of ten years or more. In these neighbourhoods also, where orchards were well cared for, especially in the matter of spraying, the disease did not appear to be destructive. Perithecia were found in considerable quantity.

"Around Kentville, Wolfville, Starr's Point, and other points in the upper Annapolis valley the orcharding is of a much better type and while cankers could be found, the amount of injury being done by them did not seem to be very great. In this region also the most susceptible variety, the Nonpareil, is grown to a less extent. Altogether it seems clear that the disease is only a menace where proper pruning and spraying are neglected.

"On the return journey a visit was paid to Dalhousie on Chaleur bay. This is apparently a very exposed point and the few apple trees noticed were very poor, stunted, and apparently much injured by climatic conditions, Here one case of *Nectria ditissima* on an apple tree was found."

Silver Leaf of Fruit Trees.—Investigations of this obscure trouble carried on since 1909, while successful so far as to prove that the peculiar silvering of the leaves may in many cases be attributed to an infection with the fungus *Stereum purpureum Pers.* for which we have conclusive evidence, leave no doubt in our minds that this curious phenomenon may result from other agents too.

The fungus *Stereum* causes the leaves to assume the silvery colour, apparently by the action of some ferment produced by the fungus, and the effect is prominently visible in the leaves; it is in this case not due to a local infection but rather an action at a distance.

We have been able to make some observations in an orchard at Salmon Arm, B.C., which proved the silvering of the leaves may also be due to a local agent, *i.e.,* acting directly upon the cells of the leaves and producing the silvery colour.

In the fall of 1912 we observed a pear tree in the locality referred to, the leaves of which showed typical silvering; the tree was marked for observation and was visited again a year later after a request by the owner, who claimed he had succeeded in controlling the disease by a simple application of Black Leaf 40, a nicotine preparation now in common use against various insects. That the claims of the owner were correct was revealed by a more careful examination. The leaves covered by the spray were nominally green, but those above the reach of the spray still showed signs of silvering. This phenomenon was now carefully examined, when it was found that the appearance of these silvered leaves differed somewhat from the *Stereum* silver leaf inasmuch as the leaf was covered with clearly defined patches of silvery area, which in some instances had become confluent, involving the whole upper surface of the leaves. This is never the case in *Stereum* silver leaf. Examination of the surface with a 20-diam. magnifying lens then revealed the presence of minute mites, apparently of the genus *Eriophyes.* No determination was made at that time of the mite, but immediately a thorough inspection of the leaves of other trees affected with silver leaf was made. with the striking result that a mite of the same kind, or closely related at any rate. was discovered. This observation no doubt accounts to some extent for the "recovery" of trees from "silver leaf" which we have not observed in the "*Stereum*" silver leaf.

In order to show the close resemblance and difficulty of distinguishing these two types of silver leaf, we forwarded specimens of true silver leaf and mite silver leaf to Mr. Brooks, of Cambridge, England, who is very familiar with this disease. On receipt of his report we found he was able to confirm our first diagnosis merely stating that the specimens should be regarded as affected by silver leaf disease. On specially pointing out the differences this observer immediately was in a position to distinguish between them.

From this preliminary statement it will be seen that two very different causes may at times result in producing very similar symptoms.

OTTAWA.

Where silver leaf exists it would be advisable to first try a spray of Black Leaf 40 or lime-sulphur just before the leaf buds open. If the disease persists it is evident that it is not caused by mites.

Dr. Waite, in charge of the fruit disease investigations at Washington, informs me in a letter that the mite observed may be identical with that described in Bulletin 283, Geneva, N.Y., Agricultural Experiment Station as *Phyllocoptes schlechtendali.*

Meanwhile the investigations into the nature of this disease are being continued.

HOUSE-FLY FUNGUS.

A fungus destructive to house-flies.—Since it has become recognized that the common house fly is a potential source of danger to the public health as a carrier of pathogenic micro-organisms, the question of an effectual and practical method of exterminating, or at least reducing the prevalence of this insect during the summer months, has attracted considerable attention.

As a means towards the solution of this problem, the study of certain organisms of fungal or bacterial nature liable to cause an epidemic among flies seems most important. As time permits, such investigations have been conducted by the Dominion Botanist. Among the commonest of fungus diseases of flies is the *Empusa Muscae* Cohn, which kills off a considerable number of flies each year. Flies killed by this fungus are conspicuous by the life-like position they retain when killed and the white spore-dust surrounding the dead bodies for a short distance. At the present time, while we have succeeded in infecting flies very readily with the fungus spores and thus causing death among them, our experiments came to an end prematurely when we failed in January to secure more flies for infection. This experience was reported for several seasons, but the end in view warrants further researches in this subject.

The value of organisms causing epidemics among noxious insects is best demonstrated by the grasshopper bacterium *Coccobacillus acridiorum,* successfully isolated and tested by Dr. d'Herelle of the Pasteur Institute of Paris.

II.—EXPERIMENTAL WORK.

As indicated in our last report, the experiments on growing potatoes on 4 acres of land "free from disease, or as free from disease as possible," have been continued during the last season. The potatoes produced were a very good crop and of splendid keeping quality. Five varieties have been grown which gave a total yield of 866 bush. and 34 lbs.

The cultural work in the field has been carried on by Mr. D. D. Gray, Farm Foreman, while this Division had charge of the treatment of the seed tubers and the spraying operations throughout the season.

POTATO-PITTING EXPERIMENTS.

Owing to the often considerable losses from storing potatoes in unsuitable root-houses or cellars, as referred to in our last year's report, we have tried the experiment of storing the tubers in a pit on the level ground. The wintering of potatoes in pits may prevent the losses from decay and prove a cheaper means than the building of cellars or houses for the purpose. Fifty bushels of four varieties were wintered in a pit constructed in the following manner:—

OTTAWA.

Two boards, each perforated by a number of 1-inch holes, of the length of the intended pit, were nailed together at an angle so as to enclose a space between them. They were then placed on the ground, the air-space between them serving for the purpose of ventilation. The boards and ground over the area to be occupied by the pit were then covered with a layer of straw 1 foot deep. The potatoes were piled thereon, forming an angular ridge. They were then covered with another layer of straw about 6 inches thick, a beam of about 8 inches in thickness was laid on the top of the ridge and the whole covered with another layer of straw and about a foot of soil then placed all round. After the whole heap had been allowed to settle properly the beam was carefully pulled out from the end and another ventilation tube resulted. Both ends of this tube were plugged with a bunch of straw to be opened or closed as the temperature of the pit required. The temperature of the pit was taken daily by means of a self-registering thermometer which could be let down on a string through a small wooden tube to about the centre of the pit. There was no heating of the pit nor any frost recorded by the thermometer. The temperature outside the pit dropped some 30° F. below zero, and a good many potatoes on the outside of the pit were found to have been touched by frost, but none were found to show anything like the storage rots which were present in the cellar and root-house. The experiment seems worth repeating. This form of pit may prove of value in a good many districts of Canada where the temperature does not go so much below zero, and it has the advantage of being of a very simple construction.

III.—ECONOMIC BOTANY.

GENERAL CONSIDERATIONS ON WEEDS.

In order to be in a position to deal with the question of weeds in a proper and scientific manner it is obvious that the more one knows about the weed and its manner of growth the better fitted will one be to combat it. In some of the older countries of the world a good beginning has been made, such as, for example, the work of Fruwirth in Germany. But this is a problem that each country must work out for itself as the mode of life of any particular weed is by no means the same in all countries. It frequently happens that when a species of weed is introduced from one country to another it spreads more rapidly and is much more troublesome than it was in the parent country. It is evident, too, that in a country like Canada, where there is great diversity of climatic conditions, any investigations which are to be of value would require to be carried out in several provinces of the Dominion. As indicating lines along which investigations might profitably be conducted, the following are some of the more important headings on which complete information seems desirable:—

(1) Whether the particular species of weed is a native of Canada or has been introduced from some other country. If introduced, the manner of its introduction should be known as far as possible and whether it is still being introduced among farm or garden seeds at the present time.

(2) Its geographical distribution in the provinces of Canada.

(3) Its relation to soils of various kinds. It is well known that some weeds have a decided preference for a limy soil, others prefer a soil in which lime is almost entirely absent, while there are others which will grow equally well on either.

(4) Its relation to the various crops grown on the farm. Some weeds thrive best on tilled land while they disappear or at least are held in check if a hay crop be

grown. Some, such as Orange Hawkweed, grow rapidly on cultivated land and are equally at home on stony pastures. It is evident in a case such as this that the same method of eradication cannot be prescribed alike for the two cases.

(5) Its natural method of spreading, whether by seeds, surface runners, underground stems, etc.

(6) If spread by seeds or fruits, the manner of its dispersal should be known, whether the fruits are carried by wind, as in the thistles, or by animals, as in the case of blue bur, or have no special mechanism for dispersal.

(7) Time of flowering and time of ripening of the seeds. In some cases the latter will coincide with the ripening of the crop among which it is growing while in others it may be earlier or later.

(8) Time of germination of the seeds when self-sown in the ground.

(9) Vitality of the seeds when buried in the soil. Opinions seem to differ as to how long the seeds of weeds can remain alive in the soil, and further investigations will be necessary before the point can be accurately determined. Seeds, if kept dry, appear to lose their vitality much quicker than buried seeds. There is no doubt that many of the latter can germinate after being buried for twenty years.

(10) Relation to moisture. The problem of destroying weeds is rendered more difficult in a region with light rainfall, such as Alberta. Here the usual method of ploughing the weeds under after they have germinated is scarcely applicable at certain seasons of the year, as the supply of moisture is not sufficient to induce the seeds to germinate. Some weeds grow best where the soil is fairly damp; drainage retards them and enables other plants to crowd them out.

(11) Relation to temperature. As regards the exact temperature at which weeds or weed seeds are killed by frost, we have little, if any, reliable information.

(12) The susceptibility of weeds to chemical sprays. A number of experiments have been made showing the action of various sprays such as copper sulphate, iron sulphate, etc., on various plants, but the series of experiments ought to be extended, and other chemical substances tried at various stages in the plant's history. It is just possible that a spray which would have no effect on the foliage might injure the flowers sufficiently to prevent the formation of seeds.

A knowledge of the life-history of a weed in the widest sense as outlined under the headings above would render the weed problem more easy of solution, especially if aided by effective legislation.

POISONOUS PLANTS.

We are glad to note that the number of cases of poisoning due to plants reported to us has not increased; but we still receive numerous requests for literature on poisonous and medical plants, with specimens for identification. The plants which we have had most inquiries about, are given below. They are arranged in the following manner in the hope that although some of them are well known by their common name and appearance, the additional knowledge of their poisonous nature may avert danger.

POISONOUS.

Actaea rubra (Red baneberry).
Actaea alba (White baneberry).
Anemone patens var. *Wolfgangiana* (Prairie anemone).
Cicuta vagans (Water hemlock).
Daphne Mezereum (Daphne).
Equisetum arvense (Horsetail).
Iris versicolor (Blue flag).
Lobelia inflata (Indian tobacco).
Oxytropis Lamberti (Loco weed).
Rhus Toxicodendron (Poison ivy).
Sium cicutaefolium (Water parsnip).
Solanum Dulcamara (Bittersweet, nightshade).
" *nigrum* (Black nightshade).
Taxus canadensis (American yew).
Trillium erectum (Red trillium).
Trillium grandiflorum (Large-flowered trillium).
Trillium undulatum (Painted trillium).
Zygadenus undulatum (Death camas).

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MEDICINAL.

Acorus calamus (Sweet flag).
Aralia nudicaulis (Wild sarsaparilla).
Apocynum androsaemifolium (spreading dogbane).
Coptis trifolia (Goldthread).
Hamamelis virginiana (Witch hazel).
Hydrastis Canadensis (Golden seal).
Panax quinquefolium (Ginseng).
Polygala Senega (Seneca snakeroot).
Solanum Dulcamara (Bittersweet, nightshade).
Trillium erectum (Red trillium).
Trillium grandiflorum (Large flowered trillium).
Trillium undulatum (Painted trillium).

SUSPICIOUS.

Apocynum androsaemifolium (Spreading dogbane).
Nepeta hederacea (Ground ivy).
Menispermum canadense (Can. moonseed).
Pastinaca sativa (Wild parsnip).
Solanum triflorum (3-flowered nightshade).
Thermopsis rhombifolia (Prairie thermopsis or false lupin).

This list by no means comprises the poisonous and medicinal plants of Canada but only those about which we have given information this year.

BOTANIC GARDENS.

The past year on the whole was favourable, although during the continued dry weather many of our experimental plants perished, owing to the lack of watering facilities in the gardens.

Great success has been obtained in growing the English primrose (*Primula vulgaris*) out-of-doors in Canada. A spot was chosen for it under the trees in the arboretum where it enjoyed as nearly as possible the conditions of its natural environment.

The seeds for exchange purposes this year included 519 different species gathered from plants in the Botanic Gardens. Upon request, over 800 packets of these seeds were sent to foreign Botanic Gardens and to persons interested in Canadian plants.

The labelling of the plants in the half mile of perennial border with the nomenclature of Engler and Prantl is being continued.

HERBARIUM.

Many specimens new to the herbarium have been added during the year. These were collected by the staff, in British Columbia, and at Quebec, l'Islet and Rivière-du-Loup.

Our thanks are due to Mr. W. H. Brittain for the presentation of fifty different species collected at Vernon, B.C.

GERMINATION TESTS OF WILD RICE.

Sowings of wild rice seed had been made at the Farm in the autumn of 1911. In the spring of 1912 it was found that the seeds which had been left dry in the laboratory for a few days before sowing, germinated quite as freely as those which had been sown immediately after gathering from the plants. This fact gave rise to the question, was it possible to keep fresh wild rice seed in a dry condition without impairing its germinating power long enough for transportation across country? This question is of very great importance in establishing wild rice, as for many reasons the autumnal sowing is preferable to spring sowing of seeds specially stored during the winter. To answer this question germination tests were made, during 1912 and 1913, of seeds which had been kept dry from one to twenty-one days.

The result of these tests proves that wild rice seed kept in a dry condition for one week after date of gathering will give from 72 to 96 per cent of germination; for two weeks, 60 to 74 per cent. The three-week test gave 76 per cent in one case and for some unaccountable reason only 2 per cent in the other.

OTTAWA.

A packet of dry seeds was sent to the Royal Botanic Gardens, Kew, London, England. The seeds which had been kept dry for twenty-five days germinated 42 per cent, which result was 20 per cent better than the test of the seeds sent wet.

In all cases the seeds from western Ontario gave the best results. They are much larger seeds than those gathered near Ottawa. But it is important to point out that the latter seeds were at a great disadvantage from the beginning, as after being gathered they were spread out in the hot sun and left there unprotected for a whole day. This is not at all necessary if ordinary precautions are taken. The seeds should not be gathered just after a rain when the whole plant is naturally wet, nor should they be put into a wet boat. Only the mature seeds drop off readily from the stalk so that in gathering there is very little chance of getting young and "milky" seeds. If, however, there is any danger of fermentation, the seeds may be spread out for a few hours in a dry atmosphere but protected from the sun. They should be turned over two or three times to let the air thoroughly through them. On no account should they ever be exposed to intense heat.

QUEBEC WILD RICE.

The seeds of the Quebec wild rice are only half the size of those from western Ontario. The plants are also very much smaller. As is well known, there are two species of wild rice growing in Canada, i.e., *Zizania palustris* and *Z. aquatica*. We are not yet in a position to state whether the Quebec wild rice is *Z. aquatica* growing under adverse circumstances due to tidal conditions, or whether it is a variety of the same. It was found growing in abundance both on the north and south shores of the St. Lawrence river. At Beauport, there is a large stretch of low land on the Beauport flats which the inhabitants call "La Canarderie" where the wild rice is most abundant, and where the wild ducks flock to eat it. Wild rice was also found at Cap Rouge, Montmorency, and Ste. Anne station. On the south shore, it was growing at St. Joseph de Lévis, just below the graving dock, at Lévis above the Grand Trunk station, at Hadlow, and along the shore up to New Liverpool. No doubt it also grows on both sides of the St. Lawrence for a considerable distance below Quebec, as it was found in abundance at L'Islet, 50 miles from Quebec. There was, however, no sign of it at Rivière-du-Loup, owing to the salinity of the water.

IV.—MISCELLANEOUS.

INTERNATIONAL PHYTOPATHOLOGICAL CONFERENCE.

The Dominion Botanist was appointed by an Order in Council to represent the Dominion of Canada at the above conference held in Rome from February 24 to March 4, 1914. The conference, which was held at and under the auspices of the International Institute of Agriculture for the purpose of securing international co-operation in the control of plant diseases, was summoned by the Government of France in conjunction with the Italian Goverment. His Majesty the King of Italy, in person opened the conference. Thirty-one countries were represented by sixty-three delegates.

A series of meetings was held at which the delegates expressed the general desire of their respective Governments to abide by previous decisions of the General Assemblies of the International Institute of Agriculture, and to continue the measures already agreed upon at previous agricultural congresses. The conference, without in any way interfering with the measures adopted under existing international agreements, drew up a draft convention, dated March the 4th, 1914, to be submitted

to the various Governments for approbation, and signed by the plenipotentiaries nominated for the purpose if approved.

The convention comprised twenty articles in which are specified the special requirements for an organization of an adequate official phytopathological service. This official service will include as a minimum: (1) the creation of one or more research stations for scientific and technical investigations, (2) the organization of an efficient supervision of cultivation, (3) the inspection of consignments, and (4) the issue of phytopathological certificates.

In connection with the attendance at the conference in Europe, the Dominion Botanist was authorized to visit some of the principal agricultural plant pathological and milk bacteriological institutions of the continent of Europe.

EVAPORATED POTATOES AND THEIR ECONOMIC VALUE TO AGRICULTURE.

One of the various subjects inquired into on the occasion of the visit to Europe was in connection with the process of drying potatoes, which is largely practised in Germany.

The necessity of using potatoes in a dried condition—quite apart from their recognized value for human consumption, stock food, or for technical purposes—will and must largely depend upon the total production of potatoes in the country if such practices are to be carried on with profit. As soon as there exists an over-production, potato drying might well be made the subject of closer study. In Germany the production of evaporated potatoes has increased to a very great extent in the last few years. This is due: First, to the over-production of potatoes; second, to cheaper labour and freight charges; and third, to the perfecting of machines carrying out the process. In Canada, none of these salient features exists, and it will be necessary before pronouncing an opinion in favour of or against this process to take the conditions existing in the Dominion into careful account. The most important question is, naturally, "Is the value of desiccated potatoes so great as to warrant establishing this industry in Canada?" The real commercial value of them as an article of food for man and animals will depend largely upon the cost of production, and that is where a country like Germany has a great many advantages. To begin with the price of potatoes is considerably higher here, and it is a subject of experiment if a profit will be gained from the finished article. It must be remembered here that, generally speaking, 3½ bushels of raw potatoes will produce about 1 bushel of dried potatoes, but this will vary according to the starch contents of the potatoes used.

The cost of production in Germany per bushel of dried potatoes is about 2½ cents The price of raw potatoes in Germany varies from 20 cents to 25 cents per bushel, and in the form of dried flakes the price per bushel is from 80 cents to one dollar. On the face of it, it would seem that at the present time this industry will hardly prove of value to Canada. At any rate, careful experiments will have to be carried on first to try this process here. The advantages of potato evaporation may be summarized as follows:—

(1) Evaporation of potatoes would consume all potatoes for which there is no other market, and which would otherwise go to waste.

(2) Through the process of drying, a considerable amount in cost of transportation will be saved.

(3) The nutritive value of evaporated potatoes will not be influenced by heat or frost, and they will keep indefinitely, if at all reasonably stored.

(4) They occupy less space and will be a very useful stock food in years when other food is scarce.

(5) Potato evaporation would be one means to solve the problem of utilizing potatoes affected with diseases, which are now being sold and tend to spread diseases over a wider area.

Inquiries into this subject will be pursued before further comments are made.

OTTAWA.

THE SIGNIFICANCE AND PROBLEMS OF AGRICULTURAL BACTERIOLOGY.

In connection with the European visit of the Dominion Botanist, several bacteriological institutions were visited, and from the specialized attention which is being paid in other countries to this fundamental basis of agricultural economy, a few remarks on the significance and the problems of this branch of agriculture will not be found out of place in the present report.

The practical significance of agricultural bacteriology consists in educating the farmers to avail themselves to the utmost extent of the aid of bacteria and fungi with which they come into daily contact, without at present realizing to any extent their important rôle in the household of nature. Many of the technical measures in agricultural practice are aimed to directly or indirectly influence the life and activity of the useful or injurious micro-organisms. Much success has already been achieved by the use of the pure cultures of certain leguminous bacteria for the improvement in the field of such crops. On the other hand, bacteria may show themselves of as great value, as at times they may be injurious, in the conservation of various feed materials, the production of clean milk, the manufacture of butter and cheese, the decomposition and use of stable manure, and last but not least, the action of fungi, bacteria, and protozoa in the soil may exert a decidedly beneficial or a very injurious influence, as the circumstances may be. In consequence of a more or less pronounced indifference towards this important branch of agricultural science, many countries in the world in which extensive farming in all its branches is being carried on still suffer enormous economic losses by not utilizing the helpful assets in the form of agricultural by-products to the fullest extent. One example may suffice here which will clearly indicate the great gain by the correct use of stable manure. It has been demonstrated that this valuable asset to agriculture is more generally utilized to only 3 per cent of its value, while a study of the action of organisms in manure has shown that at times it may be used to more than 40 per cent of its value. Depending upon the length of time it has been lying in a heap, the value of stable manure is often considerably reduced by the action of bacteria. Another feature of bacteriological nature is the incomplete utilization of green manure; surprising seems the influence of such matter upon the micro-flora of the soil, providing it is used at the proper time. On the whole the usefulness of bacteria in relation to agricultural practices is very pronounced; serious losses through wasteful practices due to imperfect knowledge of the usefulness of such organisms will be averted by a close study and practical application of the principles of agricultural bacteriology.

Some of the more important and immediate problems in this connection may be cited:—

(1) Investigation into the changes during storage of the various kinds of animal manures. (Losses of nitrogen, availability to crops of nitrogen, utilization of other plant nutriments, influence of various methods of conservation.)

(2) Maintenance of soil fertility, through timely supply of humus, culture of crops increasing the fertility of the soil, suitable rotation and rational methods of cultivation. (Experiments in humification processes, green manuring, influence of crops on the micro-flora of the soil, summer and winter fallowing, etc.)

(3) The study of changes in the milk, butter, and cheese. (Efficient mode of treatment of dairy utensils, milking machines, etc., butter and cheesemaking from pasteurized milk by the use of pure cultures.)

(4) Conservation of potatoes, roots, etc., through pure cultures, particularly the ensilage of nitrogenous plants (clovers, etc.).

A closer attention to the study of the micro-organisms that may be employed to advantage in agriculture would soon reveal their enormously useful activity, while it would also result in demonstrating the losses due to the injurious groups, which by skilful practice and by aid of advice such as can only be obtained from close researches, will soon not only become averted but turned into a profit.

OTTAWA.

V.—REPORT OF ST. CATHARINE'S FIELD LABORATORY FOR 1913.

The work of this laboratory has been carried on under much better conditions than in 1912, owing to improved laboratory accommodation and to the additional equipment which was installed during the year. According to the plan which has been followed since the Station has been in existence, the work has proceeded along three lines. Of these, research work in plant diseases is considered of primary importance and has received the most attention. A second branch of the work has in view a general oversight of the Niagara peninsula, so as to obtain as accurate a knowledge as possible of the prevalence and spread of diseases now present, and of the introduction of new diseases. The third phase concerns the identification of plant diseases and the giving of advice regarding their control. Since during recent years there has been a considerable influx into the fruit-growing industry of men from other occupations many of whom have had little or no experience, this advisory work has been and will continue to be of special benefit to these new-comers.

During the year, the collection of disease specimens has been considerably augmented, and numerous photographs of these have been taken from time to time. From these photographs seventy-five lantern slides have been prepared for use in illustrating addresses.

An exhibit of about thirty diseases of local occurrence was prepared for the St. Catharines Fruit and Flower Show and because of the interest manifested in it, it is proposed to make a similar exhibit next year, but on a larger scale. All the meetings of the local Fruit Growers' Associations were attended as far as possible, and short addresses given on topics relating to diseases. The results of the experimental work carried on will be published in the form of a bulletin. A bulletin on fruit diseases and their control as far as they have been investigated in the district up to the present has been prepared, and will be published shortly.

General Conditions in 1913.

The spring of 1913 began early and a good deal of spraying was begun by March 20. A succession of late frosts occurred during the blossoming season, however, and some damage was done to the cherry crop, but the fertilization of the peaches had already taken place, and the young fruit was sufficiently advanced to be unhurt by these frosts. Among the shade trees which were putting forth foliage at this time, there was a good deal of frost injury to the leaves. During July and August the weather was very hot and dry and the strawberry and raspberry crops suffered considerably from drought during the end of their season. This period of dry weather was relieved by rains which came in ample time to ensure the growth of tree fruits. The fall and early winter were characterized by exceptionally warm weather and there was no frost in the ground until January 15, 1914. Thereafter a sudden lowering of temperature took place, and a cold period, in conjunction with a similar but more extended one in February, destroyed a very large proportion of the fruit buds of the peach, besides giving rise to numerous cases of winter injury of other sorts.

Important Diseases in 1913.

APPLE.

Scab (*Venturia inæqualis* Aderh.) is the worst fungous disease met with on this fruit. During the early part of the season conditions were not very favourable for its development, and where trees were well cared for and properly sprayed, the fruit was clean. Later on in the season, however, a few orchards developed scab in the

warm moist weather following the midsummer drought and the occurrence of this late infection in orchards that had been well sprayed raises the question as to whether an additional summer spraying will not be necessary in seasons like the recent one. According to the best orchard practice at present, three sprayings are given with commercial or home-boiled lime-sulphur, the first being applied just before the blossoms burst, and should test with the hydrometer 1·030 specific gravity; the second (testing 1·009) is applied just before the blossoms open; the third (testing 1·008) is put on just after the blossoms fall, but while the calyces still remain open. The fourth application which may be necessary in damp summers should be given as soon as indications of the scab appear on leaves, where it usually first shows itself.

Black Rot (*Sphœropsis malorum* Pk.).—This fungus is responsible for the greater part of our apple rot, especially on fallen fruit. In our climate it is most seriously prevalent in the fruit on the tree, but it attacks windfalls and apples in storage. It is far less prevalent in well pruned and sprayed orchards, and a great deal can be done to lessen the infection of the fruit by keeping the trees free from fungus. Infection takes place from spores derived from old rotten fruit and also from spores formed in cankers, sun scald areas, and dead twigs. If care is taken in pruning to remove these sources of infection as far as possible, and to destroy fallen fruit, the effects of Black Rot on the fruit will be materially lessened.

Sun Scald.—Frequent cases of this form of injury are met with. It is sometimes seen on apple trunks, but may also be found on the larger limbs. Sun scald often follows an attempt to put an old neglected orchard into bearing condition. The trees are cut off so as to take away all the limbs above convenient spraying and picking height, and if this pruning is injudiciously done many of the large limbs are left exposed. In early spring the upper sides of these limbs are heated by the hot midday sun, and either because of frost which follows at night or because of inability to obtain water from the still frozen soil theses exposed areas are killed. The liability to scald may be greatly lessened by a coat of whitewash applied to the trunk and limbs. This reflects the heat from the surface and thus avoids exposure to extremes of temperature.

Collar Rot is another form of injury to apple, pear, plum and peach tree, brought about by winter conditions. The loss due to it from year to year is far more than is generally recognized, and it is apt to occur on trees just when they should have a long bearing period before them. Late cultivation which retards ripening of the tissues is conducive to the trouble, and it is worst in wet undrained soils, soils lacking in humus, and those which are hard and earthy. Mulches of straw and manure or even soil give a protection against collar rot. While numerous cases of collar rot have been met with in apples, pears also suffer considerably, and Japanese plums are quite susceptible to it under the conditions mentioned.

PEAR.

Pear Blight (*Bacillus amylovorus* De Toni).—This disease has made such serious inroads to the pear orchards of the Niagara peninsula that many of the more susceptible varieties have been given up as a profitable crop, and the entire acreage of pears has been greatly reduced in spite of the uniformly good prices that this fruit brings. The disease varies in virulence from year to year according to weather conditions which greatly affect its spread, and it is also worse in some districts than in others. In the recent summer the St. Catharines region had little or none, while quite a few orchards at Beamsville, Grimsby, and Stoney Creek were badly attacked. Control measures involve rigorously cutting out all parts affected by blight as soon as it appears, and it is especially advisable to go over the trees

carefully in the winter and cut out every speck of blighted wood so that the chances of spring infection may be lessened as much as possible. During the summer all blight prunings should be made by a knife dipped after each cut in corrosive sublimate (1-1000) so as to preclude carrying infection from tree to tree. In orchards where blight is bad, as a preventive measure it is generally found that it is better to do as little cultivation as will ensure the proper development of the fruit and to avoid all means which tend to produce soft sappy growth.

PEAR LEAF SPOT (*Septoria piricola* Desm.) occurs all over the peninsula, but ordinarily when the dormant spray of lime-sulphur as described under the apple has been thoroughly applied there is little or no trouble from this cause.

SCAB (*Ventura pirina* Aderh.) is found to be hard to control on several susceptible varieties such as Flemish Beauty, Duchess, Sheldon, Seckel, and Anjou. It has been found, however, that the treatment given for Apple Scab is effective in controlling Pear Scab as well.

COLLAR ROT.—As noted under the apple, the pear is often killed by collar rot, especially where the soil is wet, and lacking in humus.

QUINCE.

RUST (*Gymnosporangium* L. *globosum* Farl.).—Quinces are not grown very extensively in the Niagara peninsula, but among the numerous small orchards found throughout the district the chief disease which affects this fruit is the Rust. The prevalence of this disease is directly attributable to the occurrence everywhere of the red cedar on which a part of the life cycle of the Rust is passed. The most obvious method of control would be to destroy all the cedar trees within the possible limits of infection. It has been stated on good authority that the spores may travel a mile or more, so that the destruction of this source of infection could only be carried out by concerted action of neighbouring owners or else by municipal regulation. It is doubtful if under existing circumstances this method of dealing with the disease would be feasible. It has been claimed that Bordeaux mixture applied at the infection period which is about the last of April or the first of May will give satisfactory control of the disease.

BLACK ROT OF FRUIT AND LEAF SPOT (*Fabræa maculata* Atk.) (=*Entomosporium maculatum* Rev.).—These are due to the same fungus. Neither is at all prevalent where the dormant spray of lime-sulphur is used.

CHERRY.

BLACK KNOT (*Plowrightia morbosa* Sacc.).—A good deal of Black Knot still exists throughout the peninsula, principally in small gardens, waste places, and neglected farms. In the large commercial orchards it is practically non-existent, and no trouble is experienced in keeping them free from it by the simple expedient of cutting out all knots as soon as they appear. The winter pruning is usually sufficient, but as spores are formed twice in the season, once in early spring and again in late fall, greater security from infection is obtained by an additional summer inspection and removal of the knots.

BROWN ROT (*Sclerotinia fructigena* Schr.).—Little attempt has been made to keep this disease in check, and yearly there is a considerable loss from it, mainly among sweet cherries. In 1913 a few days of moist warm weather just at the end of the sweet cherry season resulted in a large amount of rot.

SHOT HOLE (*Cylindrosporium padi* Karst).—This leaf affection is more or less universal on the cherry, and while it is usually not sufficiently severe to warrant the

expense of spraying, yet in certain cases trees are almost completely defoliated by it. When infection occurs at the time when the leaf is expanding the affected portion dries up and falls out, producing the true 'shot hole,' but infection later on in the season may only result in the formation of leaf spots. Control should include the dormant spray of lime-sulphur in the spring and the destruction of affected leaves. Where further measures are needed, half-strength Bordeaux made alkaline by excess of lime may be used, but there is danger of burning the leaves, especially in hot dry weather, if the ordinary mixture is applied.

PEACH.

LEAF CURL (*xcavasus deformans* Fuckel).—A few bad cases of Leaf Curl were noted in 1913, and in every case where the disease was met with, the controlling spray of lime-sulphur had either been carelessly applied or had not been applied soon enough in the spring.

Canker.—The Gummosis cankers of the peach are quite prevalent throughout the peninsula, and while no notable increase in their number took place during the year, those already formed made their usual yearly increase in size. On account of the prevalence of cankers at the bases of twigs killed by Brown Rot and other fungi, it is advised that care be taken to carefully remove these every summer so that conditions may not be left which are favourable to canker formation the following spring. Treatment of cankers which infest the main trunks or limbs of trees is well worth while. These should be carefully cleaned out, washed with corrosive sublimate (1—100) and when dry painted with ordinary lead paint.

MILDEW (*Sphærotheca pannosa* Lév.).—The ordinary commercial varieties are very little troubled with this disease, but a few varieties are very susceptible to it. The Toronto and Brecken are badly attacked and often serve as sources of infection to other nearby trees which would of themselves be immune. The disease is readily controlled by dusting with flowers of sulphur or by the use of self-boiled lime-sulphur applied when the first signs of the disease appear. It is found that none of the susceptible varieties possess sufficient advantages over the immune varieties to warrant their retention under conditions that necessitated yearly spraying, so that they are being quickly discarded by all practical growers.

YELLOWS AND LITTLE PEACHES.—Under the efficient system of inspection now employed by the Provincial Government, these diseases have during the last three years undergone a remarkable and encouraging decrease, and it is hoped that in ensuing years the percentage of trees destroyed from this cause will become very small.

PLUM.

BROWN ROT (*Sclerotinia fructigena* Schr.).—Still continues to take its toll of the plum crop, and was sufficiently serious during 1913 to warrant attention. An attempt to deal with this disease requires: (1) the destruction of rotten fruit by ploughing deeply under, in fall or early spring; (2) the removal and destruction of the mummies from the trees; (3) a cleansing spray of lime-sulphur (1.303 sp. gr.) before growth starts, to kill all spores adhering to the bark and limbs; (4) summer spray to prevent infection from spores which have escaped (1), (2) and (3), or others which may be brought in from elsewhere. For this spray self-boiled lime-sulphur is recommended. According to Scott, the first spraying should be given about three weeks after the petals fall, the third a month before the fruit ripens, and the second midway between the first and third.

SHOT HOLE (*Cylindrosporium padi*, Karst.).—With the exception of Japanese varieties, plums are not usually seriously affected by shot hole. In the Japanese var-

ieties there is a good deal of the shot hole effect on weak or unhealthy trees, but on ordinary plums the fungus only attacks the leaves late in the season when they are declining in vigour. Under these conditions leaf spot is only produced as a rule.

SUN SCALD.—An injury similar to that discussed under the apple is very common on plums throughout the Niagara district. The part usually affected in this case is the trunk, and whole orchards may be found in which the trunks of all the trees have dead strips on the south or southwest sides. The injury is caused by winter conditions and, as in the case of apples, whitewash applied to the trunks in fall or early winter helps to prevent it. Trees already injured should have the dead areas cut out and painted.

W. A. McCUBBIN.

ACKNOWLEDGMENTS.

In concluding this report I desire to express my indebtedness to the members of my staff who have, through their industry and close attention to their duties, considerably aided me in the carrying out of various phases of research and other work of the Division.

H. T. GÜSSOW,
Dominion Botanist.

March 31, 1914.

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REPORT

FROM THE

DIVISION OF BOTANY

FOR THE

Fiscal Year Ending March 31, 1915

PREPARED BY

The Dominion Botanist - H. T. Güssow.

REPORT OF THE DIVISION OF BOTANY

H. T. GÜSSOW, DOMINION BOTANIST.

OTTAWA, March 31, 1915.

The Director, Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to submit herewith the sixth annual report of the work carried on by the staff of the Division of Botany.

The year's work was greatly increased through special attention being paid to the administration of the Destructive Insect and Pest Act.

The Field Laboratory of St. Catharines, Ont., now established long enough to show the first results, is proving a real benefit to that district. In charge of Mr. W. A. McCubbin, M.A., a very able and enthusiastic colleague, the work is being highly appreciated by the many who have availed themselves of the advantages of the information and demonstration afforded.

The field station occupies a very useful part in the educational work from both the advisory and the practical demonstration points of view. In numerous instances, farmers and fruit growers who sought advice could be visited from such field stations and their problems be studied on the spot, which is always far more satisfactory than by correspondence, often enough the only alternative means of giving advice.

Field laboratories are not only the most satisfactory means of assisting the public, but are the principal means by which work of so highly scientific a character as that of plant pathology can be rendered useful.

Considerable attention was paid to the investigation and study of potato diseases, with a view to finding measures for their control which would not interfere too much with ordinary farm practice. The most important fact, so far as the control of potato diseases is concerned, is that farmers always appear very confident of "never planting diseased potatoes," whereas it is our experience that this is still far too frequently done, and the sooner this is realized the better. Farmers are warned that the care which at present they believe they exercise is by no means sufficient.

It is our duty and desire to render the work of this Division of the most useful nature possible. It should be remembered that we are working only for the benefit of the farming public. We have generally found that personal instructions, when paying visits to certain farming localities, prove of great value. Visits of farmers to our laboratories are always welcome, and, when we have had the pleasure of having them with us at Ottawa, they generally become valued correspondents and co-operators.

For convenience sake, this report is divided as usual into several sections, viz.: 1. Destructive Insect and Pest Act; 2. Plant Pathology; 3. Economic Botany; 4. Report from Branch Laboratory at St. Catharines, Ont.; 5. General.

1. ADMINISTRATION OF THE DESTRUCTIVE INSECT AND PEST ACT.

In last year's report we recorded the fact that the United States Government had placed an embargo on all countries, including the Dominion of Canada, where the disease "Powdery Scab" existed.

Raising of the embargo.—During the latter half of the month of June, the Dominion Botanist conferred with officials of the United States Department of Agriculture with a view to securing the raising of the embargo on potatoes. Arrangements were made by which potatoes would be allowed entry into the United States, until such time as potatoes affected with powdery scab should be found in any consignment from Canada.

Considerable time was spent in the preparation of the necessary regulations to carry on inspection and certification of all potatoes from the infected countries. A number of inspectors were appointed, who received special training at the Central Laboratory until they were found to possess the necessary knowledge requisite for the carrying out of the regulations.

The inspection of potatoes commenced in December, 1914, in the Province of New Brunswick and was directed from Ottawa. Mr. Rolf Holmden was placed in charge of the inspectors, and he has administered the regulations in as satisfactory a manner as could possibly be done. To Mr. Holmden's efforts is largely due the success of the work as far as could be expected from the regulations in force, which, it must be understood, were essential to the raising of the embargo.

The following is an account of the work carried on during the year under the Destructive Insect and Pest Act appropriation.

Field and cellar inspections of potatoes in 1914.—In order to secure accurate data of the distribution of powdery scab, a number of inspectors were instructed to make a careful survey of the potato-producing regions of Ontario. It is interesting to note that, although no doubt a fair quantity of seed potatoes used in the Province of Ontario came from New Brunswick and the United States, where powdery scab is known to exist, no indication whatever has been found that powdery scab is established in Ontario.

In Ottawa, where we have carried on a series of experiments with powdery scab under field conditions, we have not secured any results; no powdery scab made its appearance during two years of experiments. It is not possible at present to explain this curious result.

Field inspection.—During the summer months, inspection of field crops was carried on in the Maritime provinces. The object of this inspection is to keep a check on places where the disease has previously been found, and to ascertain whether farmers follow the instructions given to them concerning the prevention of this disease, and with what success.

It is gratifying to be able to report a marked improvement in this direction. No new outbreaks of disease had occurred on any of the farms visited, the farmers having followed the instructions left by the inspectors the previous year.

Since the inspection in 1912-13 of the farms of Prince Edward Island, we have been able to learn an instructive lesson. Fifty-one cases of powdery scab were located on as many different farms. On revisiting these farms in 1914, it was found that only four farmers had followed the instructions given to all of them. Of the four who had followed instructions, three had no disease on their farms, while one had evidently planted infected seed without being aware of it. This will plainly show, that, where the instructions are being followed, powdery scab is unlikely to reappear, and it also shows that it is not a difficult disease to prevent if farmers will only follow advice.

In fully 80 per cent of the instances where powdery scab has been located, the farmers have declared positively that there has been no change of seed or introduction of new strains for ten, fifteen, or even twenty years, and they were positive that powdery scab had affected their tubers for years.

OTTAWA.

One possible source of infection may be traced to the use by farmers of bags furnished them by the potato shipper, and previously used for handling potatoes. It is one of the practices of the trade to procure old bags from second-hand bag brokers, regardless of the use to which these bags might previously have been put, when shipping to order consignments of potatoes in bags; another custom is to have an equivalent number of bags returned them by the consignee. These bags are not infrequently distributed to farmers and potato growers for bagging potatoes in their cellars or potato houses. It is, therefore, not improbable that at some time or other these bags or sacks may have contained infected tubers, become contaminated with the spores, and thus become the means of carrying infection.

There can be no doubt of the part played by potato planters and diggers as disease-carrying agents. Instances where disease has evidently been carried from farm to farm by the joint use of such implements are common enough.

Railway cars used for the transportation of potatoes, which have been insufficiently cleansed and disinfected before being again used for potatoes, are another possible source of contamination.

The prevalence of minor potato diseases, other than powdery scab, in field crops was very noticeable, and the use and value of seed treatment and spraying were constantly emphasized. Such diseases as Early Blight, Late Blight, and Rhizoctonia were frequently in evidence; and in many sections of New Brunswick and Prince Edward Island, Black Leg and Leaf Roll were observed.

Potato storage conditions very imperfect.—The indifference to the proper storage of potatoes was a feature that was constantly brought before the inspectors. Very few farmers seem to appreciate the value of a well-ventilated, cool, dry potato cellar. As a general rule, they store this crop in cellars beneath the farmhouse; these cellars are not infrequently without floor other than the original soil, and are often without any other walls than the mud sides, or, where there are constructed walls, these are of stone, and in the cold of winter are continually damp. In many instances, the cellars are so poorly drained, that water lies in puddles on the floor after heavy rains in the spring or fall; it is the rule more frequently than the exception to find no provision whatever made for ventilation, with a resulting damp, unhealthy atmosphere, the temperature of these cellars frequently standing at 60° F., conditions totally unsuited to the successful storing of potatoes, and decidedly undesirable, from a sanitary point of view, for the occupants of the house above.

It is estimated that the loss from rots, due to these improper methods of storing, is fully 17 per cent (and often much more) of the entire amount stored. These conditions are general in every province visited; wherever they have been found to exist, farmers have been advised to build a potato house, if the size of the crop warranted it, or to divide the cellar into bins, with close board partitions, and raised, open, board floors made of 1 inch boards laid 1 inch apart and raised from four to six inches above the cellar floor. This would allow a certain amount of ventilation, at the same time keeping the potatoes from contact with ground water; ventilators to carry off the foul air, and prevent its rising into the house above, were also recommended.

During the latter half of October, Mr. Adams visited Prince Edward Island, and addressed meetings of farmers at the following places: Montague, Souris, St. Peter's, Tracadie Cross, Murray River, Summerside and Hunter River. Specimens of potatoes were exhibited showing disease and a description was given of the method of attack, the means by which it spreads, and the remedies to be employed in getting rid of it. A considerable number of the coloured folders on potato diseases were distributed.

A conference was also held with the members of the board of trade at Charlottetown, at which the question of the embargo on potatoes was discussed.

Ottawa.

Potato inspection in New Brunswick.—On November 4, 1914, the regulations of the Destructive Insect and Pest Act then in force, were rescinded and revised rules and regulations respecting destructive insect pests and plant diseases were substituted. Under the new form of the Act, the inspection assumed a wider field of action, with a view to the recovery of the United States market. All potatoes consigned from infected areas to the United States, or to disease-free areas in Canada, became subject to inspection, and could not be released for these markets unless certified free from powdery scab, or diseases similar thereto, by a qualified official of the Dominion Department of Agriculture.

Actual work of inspection under the revised regulations commenced in the province of New Brunswick on December 12, 1914. The inspection staff then in the province consisted of eleven inspectors, but shortly after the New Year this number was augmented by six inspectors from Nova Scotia and Quebec.

The immediate call for inspectors came largely from along the line of the C.P.R. running from McAdam Junction to Edmunston through the counties of York, Victoria and Carleton.

The preliminary work of the inspection service consisted in thoroughly acquainting the shippers with the actual working of the rules and regulations, and getting them to comply with them; slight difficulties were met with in this respect, but on the whole it was found that the shippers were anxious to comply with the law.

Method of handling and loading potatoes.—Along the principal lines running through the larger potato-growing counties of the province, the potato buyers have erected at the sidings potato houses for the storing, racking and loading of potatoes; at the smaller sidings, where the amount of trade does not justify the building of a house, potatoes are loaded direct from the wagons or sleighs to the cars. Potatoes are, as a rule, hauled in bulk to the potato houses, there racked, and all diseased, frozen, decayed, or badly injured stock removed, thus making the stock fit for the market. Before the arrival of the inspectors racking and sorting were done in a very slovenly manner in many of the houses. Where loading was done at the sidings, the racking and sorting took place at the farms. In both instances, the sorting and grading of stock were done in the presence of the inspector.

The inspector's duty was to see that disinfection requirements were carried out thoroughly, that all stock leaving his particular district was free from powdery scab, or diseases similar thereto, and otherwise fit for the markets, and that all "first grade" potatoes were, as the name implies, an A1 stock, and from an absolutely disease free source.

Actual experience in inspecting and certifying potatoes soon revealed certain minor faults in the regulations. It was found that many lots of table potatoes were being shipped out of the province, which, although free from powdery scab, showed considerable injury from the digger, or from rot, or frost, and they were so badly sorted as to often render as much as 30 per cent of them unfit for human consumption. It was immediately seen that the government inspector could not possibly "certify" potatoes in such condition. An amendment was made to the definition of table potatoes with the result that their quality rapidly improved. The shippers soon noticed the effects of more careful attention to the quality of potatoes, so much so that they were asking to have their grading made to apply to all potatoes shipped from New Brunswick anywhere.

This year the condition of potatoes was unusual, since probably 40 to 50 per cent of the potatoes harvested in 1914 in this province were marred by cuts or bruises. This feature was due to the fact, that at digging time the ground was very dry and the digging machines carried up little or no soil with the potatoes, when elevating over the carriers. The result of the loss of this protecting soil was, that the potatoes were exposed to the harsh surface of the elevator and in many instances were badly injured or cut.

OTTAWA.

Amount of potatoes inspected.—From December 14, 1914, to March 31, 1915, 80,400 bushels of first grade potatoes and 521,000 bushels of table potatoes have been duly inspected and certified. Of these 53 cars containing 41,123 bushels were shipped to the United States. The United States inspectors then found one car of Canadian potatoes to contain infected tubers with the result that all permits to import potatoes into the United States were cancelled.

Lessons from the inspection.—Notwithstanding careful training and devoted attention to the duties of inspection, it is humanly impossible for any inspector to certify and pass potatoes without allowing an occasional infected potato to pass through. The responsibility rested almost entirely with the inspector, whereas, in our opinion, it is most important that the farmer do his share of the work, and the shipper the rest. The regulations called for the inspection of farmers' crops, which was carried on as far as possible, but, when the shipping became more rapid, the inspectors had to frequently inspect and rack the potatoes, while a car was being loaded.

Furthermore, the fact that the regulations permitted the shipping of uninspected potatoes within the diseased area, resulted directly in the propagation of the disease, which it was considered important to control. The farmers would regard the inspection as a farce, because they could sell all their potatoes, irrespective of disease or inferior quality, to the shipper who shipped *within* the diseased area, whereas they immediately had to permit the racking and sorting of their potatoes with naturally a loss to themselves, when they dealt with shippers shipping *outside* the province.

2. PLANT PATHOLOGY.

Every day of the year there were received a number of diseased plant specimens for identification and suggestions for treatment. In a great many instances, the diseases are very common ones and need little attention beyond the giving of the advice sought. In others, the investigation requires several weeks or even months before its definite cause is recognized. In such cases, however, advice may often be given at once, as the general mode of spread and distribution is about the same in a good many diseases, but it is most important to carry on a study of any new or little known disease in order to discover its proper treatment. In nearly five hundred instances advice was given concerning the control of specific diseases as shown by the specimens received.

We may point out that it is very desirable to send samples of seed potatoes to this laboratory for examination before using them for seed. Commencing with sound seed is one of the most important factors in growing disease-free potato crops. We have occasionally found that firms of considerable reputation sell to farmers a class of potatoes for seed purposes which are worse than useless, often harbouring diseases which are most undesirable on any farmer's land. At the present time farmers have no protection when buying their seed potatoes.

The Division's Farmers' Circular No. 4, showing in natural colours a number of potato diseases conveyed by the use of unsound tubers, has been found a very useful publication. This has brought us many complimentary letters and requests for copies from nearly all over the world, some governmental departments considering this method of instruction one of the most useful ever brought to their attention.

Special attention is being paid by the members of the Division to the study and control of potato diseases. We are calling the attention of the growers of this important crop to several diseases in this report, and hope that a thorough knowledge of the potato diseases together with a co-operative effort towards their control will eventually stamp out the more widely prevalent ones. At the present moment very considerable damage is done by the many diseases affecting the potato plant. In some instances we have observed losses amounting from 25 per cent to 50 per cent of the total yield.

Ottawa.

DISEASES OF POTATOES.

Common scab.—In order to test the effect of fresh manures of various kinds on the production of common scab, six plots were planted after manuring as follows:—

A. No Manure;
B. Fresh pig manure with straw;
C. Fresh cow manure with sawdust;
D. Fresh horse manure with straw;
E. Fresh sheep manure with straw;
F. Fresh hen manure with straw.

The variety used was Irish Cobbler, and the potatoes were free from scab when planted. The land had not been previously planted with potatoes, but had borne a crop of turnips the previous year. After the potatoes were raised, they were washed and divided into four groups as follows: No. 1. Free from scab; No. 2. Slightly scabby; No. 3, Moderately scabby; No. 4. Badly attacked by scab. The percentages of these four groups in each plot were as follows:—

	No. 1	No. 2	No. 3	No. 4
No manure..	75·1	20·6	2·9	1·4
Pig..	72·5	22·5	3·5	1·5
Cow..	75·7	19·4	3·6	1·3
Horse..	67·7	26·0	4·6	1·7
Sheep..	81·5	15·8	1·8	0·9
Hen..	85·8	12·8	1·0	0·4

From this, it appears that fresh horse manure increased the amount of scab considerably more than did any others of the manures used, while the largest amount of clean potatoes occurred where sheep and hen manure were used.

Powdery scab.—A large number of experiments on methods of control of this disease were carried out during the year and interesting results were obtained. It has not been deemed advisable to publish these results until another series of experiments have been carried out during the summer of 1915. An exactly similar set of experiments has been planned for the Central Experimental Farm and four of the Branch Farms in Quebec and the Maritime Provinces, and it is hoped the results throughout will be of a uniform character.

*Net necrosis.**—When a potato tuber is cut across, there may be seen a large number of very small spots or areas of a yellowish colour, the rest of the flesh of the potato being of a much whiter hue. These yellowish areas are the "vascular bundles" which correspond in the potato tuber to the veins of a leaf.

During the year a considerable number of potatoes were found on being cut to have brownish internal discolourations which at first are arranged in the form of a ring, but later on become quite irregular in their distribution. These discolourations correspond to the vascular bundles mentioned above.

The disease (if it can be called a disease) begins at the stem end and gradually travels along the vascular bundles towards the eye-end, turning them brown as it proceeds. No fungus or bacterium has been found as the cause of the disease, and it is not communicated from one tuber to another by contact during storage so far as we know at present. It is of wide occurrence, having been reported during the year from New Brunswick and British Columbia. It has been suggested that "net necrosis" is an indication that the variety in which it occurs shows symptoms of deterioration, but as yet there does not seem to be sufficient proof for this statement.

* See illustration Annual Report of Dominion Botanist for the Year 1911, pl. 9, fig. B. and Farmers' Circular No. 4, fig. 2.

Some experiments were undertaken during the year to determine whether tubers that showed "net necrosis" before planting would produce a crop free from the disease, but this hope was not realized, it being found that the disease in almost every case was hereditary. Further experiments will be carried on during next season, but the only remedy that can be suggested at present is to discard all potatoes that show the brownish discolourations when cut at the stem end, and to use only perfectly sound tubers as sets.

Silver scurf.—Specimens were received during the year from British Columbia badly affected with this disease, so that its occurrence would not seem to be general throughout the Dominion. In the United States, it has recently been found as far west as the State of Utah.

Some experiments were undertaken to test the effect of fungicides in preventing the appearance of this disease, when sets that showed silver scurf were planted. Formalin, copper sulphate, corrosive sublimate, hydrogen peroxide and sulphur were used, but, as the experiments were of a preliminary nature, only small quantities of tubers were used in each case. It would be unsafe to draw any general conclusions from the results obtained, but they look promising and will serve as a basis for a much more extended series of observations next season.

Rhizoctonia or black scurf of potatoes.—(Corticium vagum solani, Burt.)—(Plate 1).—This disease has been mentioned and illustrated in previous reports, but recent knowledge of the presence of the causal fungus in the interior of the stems of the potato plant makes it of greater importance than was previously suspected. The familiar black, scurfy outgrowths on the surface of potatoes are the "sclerotia," which constitute a resting stage of the fungus. When tubers showing these sclerotia are planted, the fungus develops, as the potato plant grows, and infects the young shoots, forming brown scars or lesions on them (Fig. C). These may at times completely girdle the stem at about the ground level, and so cut off the food supply going to the leaves as well as that going to the roots for the growth of the new tubers. This disturbance often results in the production of small tubers in the axils of the leaves, as shown in Fig. A, Plate 1; or, when tubers are produced below ground, they are not usually of a marketable size.

The sclerotia previously mentioned have also been found to occur on the roots, as shown in Fig. B. In this way a field producing an infected crop would itself be infected on account of these sclerotia being left in the soil.

Our present knowledge of this disease confines us to two lines of treatment, viz.:—

1. Soaking the tubers for three hours in a solution of bichloride of mercury, one ounce in 12½ gallons of water, so killing the sclerotia on the seed potatoes.
2. A strict rotation, in which potatoes would be grown only once in every four or five years in each field, so that those sclerotia left in the field on the roots of infected plants may not be able to infect another crop, which they would do, if potatoes were planted in that field during the few years following the infected crop.

We are now treating generally all our seed potatoes in the way recommended above, and have succeeded—even on a large scale—in reducing the losses from Rhizoctonia considerably. Indeed in some years the potatoes raised on the farm from properly treated seed were almost perfectly clean.

Although at times a potato plant may show plain symptoms of Rhizoctonia infections above ground, viz.:—a curling of the leaves, which are also often lighter green to yellowish in colour—there may be no effect visible below ground beyond a few insignificant stem lesions. But in our experience the tubers produced from a plant of this description are of inferior strain and likely to produce diminished crops when used for seed. For this reason we practice careful removal of affected plants in the field in order to prevent any decrease of future yield.

DISEASES DECREASING THE YIELD OF POTATOES.

A potato disease affecting the potato tuber and readily recognizable as a disease, as, for instance, Common Scab, Powdery Scab, Dry Rot, Late Blight, Net Necrosis, Fusarium Wilt, or Silver Scurf, is not considered as dangerous as are a number of diseases which reduce the yield, but show no signs whatever on the "seed tuber." The former may easily be removed when selection of seed tubers is practised, or when cutting the sets for seed. The most important factor for the elimination of diseases of the latter group is the inspection of the growing plants and the systematic removal of all plants showing any of the symptoms of mosaic leaf, leaf roll, curly dwarf, Rhizoctonia, or black leg. Where this method is practised, the crop will be reasonably free from diseases, providing, of course, that late blight is prevented by the usual sprayings.

Black-leg of potatoes (Plate 2).—The accompanying plate illustrates the chief features of the "group" of potato diseases popularly referred to as "black-leg." Several bacterial organisms have been described, of which probably Dr. Harrison's species *Bacillus solanisaprus* and Dr. Appel's *B. phytophthorus* are the most common in Canada, if indeed the slight diagnostic differences between the two justify their separation into two species.

The potato "black-leg" disease has been observed practically in all regions of the Dominion where potatoes are being grown. It often causes considerable losses. In one instance of about 300 plants in a row, some 100 had been destroyed by this disease. The proportions were the same all over that particular field, and the loss amounted to practically 33 per cent of the yield.

Appearance of black leg.—Where infected potatoes have been planted, without due precautions, the field will invariably show a considerable number of "misses," resulting from the failure of the planted sets to grow. When digging up the planted set, it is usually a decayed, putrid, rotten tuber, or portion thereof, that is found. The black-leg germ has consumed the set entirely and prevented it from making a growth.

On examining the other plants in such field more closely, we will discover a number that are below the size of the normal plant; they are also yellowish green in colour, and their leaves are curled up, giving the single shoot a compressed appearance. In order to make quite sure of this appearance being due to black-leg, catch hold of one or more vines, pull them up, and look at the portion that came from underneath the ground. If this is black from below ground to about 3 inches to 4 inches up the stem, and either dried up, or slimy and moist, this is one more factor proving it to be black-leg disease. Fig. (b) of our plate shows a young sprout with a typical black "leg."

Fig. (a) shows a whole plant affected with black leg. The shoot in the centre is wholly killed; the other two are affected to some extent above ground and, their base being destroyed, the shoot tumbles on its side, the leaves will curl up and fade, and eventually the whole plant will die.

"Leaf-roll" disease of potatoes (Plate 3).—The importance of removing all hills in a potato field showing any symptom of disease, and thus eliminating all risks of harvesting a diseased strain of potatoes, is emphasized in the case of leaf-roll of potatoes. This disease cannot be detected by an examination of the seed potato, hence, if such are taken from a crop infected by this disease, they are likely to be planted without hesitation, and the result will be a very serious decrease in yield. It is, therefore, important for every farmer to become acquainted with the symptoms of this potato trouble to avoid serious losses in future crops.

The figures of plate 3 will plainly show what a typical hill affected with "leaf-roll" will look like in the field. The normal potato foliage shows the leaves well expanded and fairly flat; perhaps the young undeveloped leaves may show a degree of folding, which, however, is quite normal; but, when a number of plants are found, which are dwarfed and have all their leaves peculiarly rolled up, as plainly shown

in figure (b) of our plate, we have little doubt that a case of typical leaf-roll is under examination. These plants often bear a foliage slightly discoloured, at times of a lighter green, at others of a yellowish tint, or still again rather tending towards a purplish hue.

These symptoms are noticeable at a very early stage of growth and, if such a plant is watched, it will rarely be found to recover its normal appearance. On digging up a plant of this kind, we may find a number of apparently perfect tubers, indeed we have sometimes found an almost normal yield below ground; this is rather an unfortunate condition, for the tubers resulting from such plant contain the disease without showing any signs whatsoever, and are likely to be planted by the unsuspecting farmer.

If such a tuber is planted, the result will be a plant like that shown in fig. (c). This bears not a single marketable potato. At the bottom of the picture, there is shown the sound mother tuber, a few clustered tubers at the base of the stem and the thickened white stolons with small tubers attached, which will never grow to any size.

We have observed a field of potatoes recently which showed some 80 per cent of leaf-roll diseased plants, all of which bore some marketable tubers. If the farmer should plant one acre with these tubers, it would not be worth his while to harvest the crop. It has been shown repeatedly that the leaf-roll disease is transmissible, and that potatoes from a diseased plant will give little or no yield.

In order to avoid such losses, it is most advisable not to use for seed *any* of the tubers harvested from a field showing more than 5 per cent of affected plants. This may seem severe, but we must bear in mind that, though such crop still shows 95 per cent apparently of sound plants, there is a strong probability that a large proportion of these plants may turn out to be tubers, which, when planted, will grow up into diseased plants.

Where five and less per cent of affected plants occur, they should be removed immediately to prevent the harvesting of diseased tubers.

We consider this disease sufficiently serious to warrant the attention of all potato growers, particularly those growing seed potatoes.

Great care should be taken by potato growing centres in the eastern section of Canada to stamp out this disease; should this warning be disregarded, it may result in serious losses in the trade of seed potatoes.

The cause of leaf-roll is not known. For years the study of the cause has engaged the most experienced potato disease specialists, but no satisfactory solution has yet been reached. It is looked upon as a physiological trouble rather than a parasitic one; it neither spreads in the field from one plant to another, but is exclusively conveyed by using seed potatoes from a diseased crop, nor does it appear to infest the soil.

The term "leaf curl" or "curly dwarf" is often used in describing an appearance probably related to leaf roll, viz.: When the foliage of potato plants curls up very much, presenting an appearance similar to currant leaves, puckered, curled and clustered through aphid attacks. Sometimes the "curling" is so pronounced as to resemble "Scotch or Curly Kale." Such plants are of dwarfish habit and of so characteristic an appearance, that it is difficult not to recognize a typical case.

Mosaic disease of potatoes.—One of the most obscure maladies of certain solanaceous plants, to which group the potato, tomato, and tobacco belong, is the trouble popularly known as "*Mosaic Leaf Disease.*" This has for some years attracted the attention of plant pathologists in Europe and America. Nothing very definite is known of its nature, but since it has proved considerably injurious in tobacco and tomato plants, it is advisable to call attention to its occurrence on the potato.

We have no original contribution to make, at present, to what is already known about this trouble, since it has only come under our observation in Canada for two seasons. We are, however, making a careful study as opportunity affords. At present only a description of its symptoms is being given to enable students and others interested to recognize it.

OTTAWA.

Mosaic leaf disease is not recognizable on examining a potato tuber. In tobacco the disease is not considered hereditary. In the tomato this point is still subject to some controversy. In the potato, a plant almost exclusively propagated vegetatively, through its tubers, the disease is, according to our observation, transmitted through tubers harvested from a plant showing symptoms of Mosaic. Some observers record that it is spread by contact, by alternately touching diseased and healthy plants. It is considered an infectious disease. At present we cannot confirm these reports. One fact, however, is worthy of record as far as our observation is concerned. The sound leaf of plants is a complicated "plant" for the manufacture of food. Any impairment in its construction, or deviation from its normal functions, the former of which is recognizable by microscopical examination, whilst the latter is a deduction from such observation, naturally reduces the activity of the leaves as manufacturers of food; hence the potato underground must suffer according to the intensity of the trouble present. This is the actual case. Mosaic disease-infected plants do not consecutively yield normal crops. For this reason, it is advisable to pay heed to its presence and avoid the use for seed of tubers produced by an infected crop.

The following is a description of the disease as we have observed it:—

Mosaic leaf disease manifests itself by producing in the leaves a mottled appearance, which is more or less readily visible. The mottling is due to irregular patches of lighter green to yellowish areas appearing all over the leaf. This discoloration is not very clear in sun light, but, when holding in the shade a leaf of a plant which is suspected of Mosaic disease, and comparing it with that from a sound plant, it will show up the mottled appearance much more strongly.

The lighter coloured areas, which by no means give one the idea of a "sick" leaf, are slightly thinner than the normal portions of the same leaf. The difference is often so slight as to be perceptible only after microscopic measuring. The leaf may also be puckered, particularly when the disease is in an advanced stage. In the variety "Red Bliss" we have seen the disease worst, but other varieties, like "Cobbler," and "Green Mountain," have also been observed to be infected. Accompanying these symptoms, from which the disease has obtained its name, there may be observed a curious rosette shape formed by the younger leaves. The affected plants are often of normal size, and bear a normal crop, when observed for the first time.

In plants grown from a potato taken from a typical mosaic leaf plant, the leaves show the mottling very plainly, they do not grow very vigorously at first, but may later pick up somewhat in vigour, and yet produce some few good-sized tubers. It is generally after a few years that a decline in yield is observed. There are no constant symptoms visible externally on any other part of the plant.

When potatoes are raised for seed purposes, the presence of more than 5 per cent of Mosaic disease should disqualify the field altogether. Though the nature of the disease is so little known, the indications are that it may prove a very objectionable trouble, so that it is advisable to take every possible step to prevent its propagation by affected seed potatoes.

CLOVER AND ALFALFA WILT DISEASE.

Clover and alfalfa are among the most useful fodder plants grown in Canada, and any disease likely to prove destructive to these crops should be speedily recognized and prevented from doing serious damage. Generally speaking, Canada is fairly free from clover diseases. The alfalfa leaf spot, which occasionally may result in severe losses of herbage, occurs now and then, but, though widely prevalent, cannot be said to be a very serious disease.

It is different with the clover and alfalfa wilt, should it become in this country anything like as serious as it has proven itself to be in the old world.

(Photo by F. L. Drayton.)

A. The parts above ground of a potato showing axillary or aerial tubers common in Rhizoctonia disease.
B. Portions of roots showing dark-coloured sclerotia of the fungus.
C. Portion of the stem of potato below ground, showing the dark spots or lesions caused by the fungus.

(Photo through the courtesy of Dr. W. A. Orton, U.S.A. Dep. of Agric.)

A. A potato plant dying from an attack of Black-leg.

B. A young potato shoot showing the typical "black-leg" or killed portion of the stem below ground.

C.—F. A number of tubers showing black-leg infections.

(Photo through the courtesy of Dr. W. A Orton, U.S.A. Dep. of Agric.)

Leaf Roll Disease of Potatoes.

A. Two potato plants showing typical rolling up of leaves.
B. This plant shows the leaf roll disease very plainly.
C. Underground portion of a potato plant affected with leaf roll. Note the parent tuber planted, at bottom, which has not been consumed and the few clustered tubers towards the crown. No marketable tubers in this case.

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While writing these lines, we have only observed two authentic cases of this disease. One was reported to us from the experimental plots of the Agricultural College at St. Anne's, Que., and the other appeared in a small plot on the Central Experimental Farm. In both cases the damage to the crop was negligible. An examination of clover fields in other sections of the country will be made, and until this has been completed, nothing further can be said about its present distribution.

In the United States, this disease, or one apparently identical from the records, appears to have been known since 1889 when it was first recorded from Delaware. Prof. Stewart of Geneva, N.Y., records a wilt of alfalfa observed in 1899; from his description and plate it appears the same as that under our consideration. The same is the case with a disease on alfalfa recorded by Prof. Jackson of Oregon. It is evident from the existing accounts that the disease has not shown itself very destructive so far in America.

In Europe, particularly in England, clover lays are frequently destroyed in an alarming manner. It is generally held that such land has become "clover sick," by which is meant that it cannot grow any more clover once a clover crop has failed. This condition is considered by the agricultural chemists of that country to be due to some changes "within the range of the root" indicating some chemical deficiency, or change of the soil detrimental to the growth of clover. Even though it has been shown that the trouble is due to a fungus disease, the particular disease mentioned above, the chemical experts still view the matter from the chemical point of view rather than the biological.*

Appearance of clover or alfalfa wilt.—After winter, when these leguminous plants would normally start into growth by sending up fresh new shoots from the underground rootstocks, there may be observed in the field larger or smaller patches which remain bare. It is not infrequently given as an explanation that "the clover on these patches has been winter-killed." It is, however, peculiar that a number of plants in certain small patches only should be killed by the winter, while the rest start vigorously into leaf. In some instances, no doubt, such appearance may be caused by the plants having been killed by frost or ice, particularly when, for some reason or other, the snow covering was insufficient or wholly missing, but a careful examination of the clover plants early in the season will invariably reveal the true cause. We have observed a number of bare patches in our small plot, and being familiar with the appearance of clover wilt, hunted for evidences of same. The plants growing in the neighbourhood of the bare patches were carefully examined and a number of wilting plants were found. These had made (about the middle of May) a growth of some four to five inches and the shoots looked sickly and limp, as they might appear after a severe drought. The leaves had turned a darker green than shown in sound plants, and the bottom leaves were shrivelled, brown in colour, and quite dead. The plants were dug up and examined carefully. From this preliminary examination, we were fairly certain that it was a case of clover wilt. Microscopical examination, while on the whole giving us additional clues, did not absolutely confirm our opinion, inasmuch as the tap root of the clover was found to be attacked by the Clover Root Borer (*Hylastinus obscurus*). Diseased tissue was cut out which showed plenty of mycelium of a fungus and was placed on a nutrient substance. This method resulted in absolute proof of the identify of the disease with our knowledge of clover wilt as causing clover sickness in England. Typical sclerotia developed which were identical with those obtained from the diseased material from St. Anne's, Que.

Farmers are, therefore, requested to look for the "patches" in clover or alfalfa fields and immediately to send in suspicious looking plants showing the symptoms described.

* H. T. Güssow, Clover Sickness and its cause, Journ. Roy. Agric. Soc. of England, Vol. 64 entire series, pp. 376-391.

Cause of clover wilt.—The clover wilt is caused by a microscopic fungus, known to us by the scientific name *Sclerotinia ciborioides.* Other investigators refer to it as *Sclerotinia trifoliorum* but this is a matter of botanical nomenclature. Those who consider the fungus as identical with *Sclerotinia libertiana* Fckl. have no doubt their reasons. In cross inoculations made in this laboratory, we readily produced the typical soft rot caused by *S. libertiana* by using sclerotia of that fungus produced in pure culture for inoculating carrots, while in no case did we succeed in doing this with pure culture material of the fungus isolated from clover. When examining clover or alfalfa plants killed by this disease, the most striking and characteristic feature is the presence of a number of black bodies of a horny substance varying in size from the head of a pin to a wheat grain. These black bodies in clover appear more or less deeply embedded in the tissues of the crown of the root or in the tap root itself. In alfalfa they may also appear inside the split stalk, as well as on the outside of same. The botanists call these bodies *sclerotia* and consider them specially organized masses of fungus mycelium, which serve the purpose of reproducing the same. The clover wilt fungus produces an abundance of mycelium, which penetrates the tissue of the plants and envelopes the crown, stem and leaves with a dense growth. From this growth the *sclerotia* are eventually produced and, when full size, drop to the ground where they hibernate. In spring, these *sclerotia* produce a fruiting stage consisting of one or more stalked cup-shaped receptacles, furnished with a layer of minute spore sacs, bearing reproductive spores. These spores are then shot out of the sacs and germinate on the clover plants, where they continue to grow and finally, towards the end of the season or throughout the season, again produce *sclerotia.*

These *sclerotia* remain alive in the soil, which they closely resemble, for a considerable period. Sometimes such large numbers of *sclerotia* accumulate in the soil as to prevent any clover from growing; this factor has led to the belief of the land having become clover sick. This is not the case, because on removing nine inches of the top soil of a small plot showing all characteristics of "clover sickness" and picking out of it an enormous number of *sclerotia*—and returning the same soil again to the plot, a beautiful even stand of clover was obtained at once.

In agricultural practice, the removal of the *sclerotia* is impossible. Their destruction in the soil is likely to be equally impracticable. This disease again points out the absolute necessity of practising rotation of crops. There are two possible means of eradication: (1) Spraying of clover fields with some fungicide, just as the spraying of potatoes is practised, or (2) the selection and breeding of resistant strains, both of alfalfa and clover.

Much research is still required before more definite information as to the control of this disease can be given. When the disease is noticed in a field, the sooner in spring the dead patches are taken up for a depth of about six inches the better. They should be filled in with new soil and may be resown with clover. The soil removed, which most likely contains a large number of *sclerotia,* should not be conveyed to any place whence it may find its way eventually back to the land and distribute the disease. It might be spread in the centre of a road actively in use by traffic.

3. ECONOMIC BOTANY.

A large number of weeds and other plants for identification were received during the year. More than half of these were sent in during the months of July, August and September, but some specimens were received during each month of the year.

The following table shows the number of specimens sent in for examination from each province of the Dominion:—

Nova Scotia	22
New Brunswick	57
Prince Edward Island	156
Quebec	198
Ontario	182
Manitoba	41
Saskatchewan	121
Alberta	112
British Columbia	60

These with a few specimens from unknown localities give a total of 955 reported on during the year.

IDENTIFICATION OF PLANTS.

A number of the above specimens were plants that were suspected of poisoning cattle and horses. In many cases, however, the plant sent was dug up by the farmer from the field where his cattle were grazing and was not a poisonous plant. It may be desirable to point out here that the only satisfactory way of establishing cases of poisoning by plants is to open the stomach of an animal that has died and remove all vegetable matter and soak it in 20 per cent formalin for two hours. This acts as a disinfectant and serves to remove any offensive smell. It should then be taken out of the formalin and allowed to drain for a few minutes, wrapped in a piece of cloth, and sent in a tin box to Ottawa for examination.

As might be expected, a considerable number of plants sent in were weeds of cultivated land and were accompanied by a request for the easiest method of eradicating them. But in addition to weeds, specimens were also received of various native shrubs and trees, and wild fruits, indicating a widespread interest in the native vegetation of Canada. Probably the largest consignments of specimens were from school teachers and were collected in the locality where the school was situated. There is no doubt whatever but that this is a kind of work deserving every encouragement. Instruction of the rising generation in the names and habits of common weeds and native plants generally will not only add to their interest in country life afterwards, but will enable them to carry out farming operations with more success and intelligence.

In this connection a few useful hints on the sending of plants for identification may be useful. Frequently we receive plants which are so dried up and brittle, with the leaves shrivelled or matted together, that they have to be soaked out before examination, and consequently much time is lost. It sometimes happens that the plant reaches us in the form of powdered fragments and is, of course, unrecognizable. Sometimes we receive a few inches of the root only, or a single leaf, or fruit, and we are expected to name the plant from a mere fragment. In some cases this is possible, but as a rule it is very difficult.

1. Wild plants only or weeds should be sent. Garden flowers, cereals, seeds, etc., should be sent to their proper departments.

2. All plants sent for identification should, if possible, be in flower or fruit. The underground parts as well as the lower leaves should in all cases be sent.

3. Fresh specimens can usually be identified much more quickly than dried specimens. They should be sent in a tin box. If a wooden box is employed, the specimens should be wrapped in damp moss or blotting paper.

4. Dried specimens should have the leaves carefully flattened out and should be sent between sheets of stout cardboard. This is necessary to keep them from crumbling to pieces, as they are very brittle when fully dry. Specimens may be dried by laying them between sheets of blotting paper and spreading them out flat, placing a weight on top and changing the paper several times until they are dry. The flowers of dried plants have frequently to be soaked in water, and hence their identification is much more tedious.

5. Each specimen should have a number attached to it and the sender should keep a similarly numbered set for reference. As a general rule, specimens are not returned. Several specimens of each plant should be sent.

6. It will greatly facilitate the work of identification if a short note is added, stating where each species was found growing, whether in a wood, marsh, cultivated ground, etc.

7. Large collections of dried plants should be sent for examination during the winter months. As large numbers of plants, especially weeds, are sent for examination in early summer with a request for methods of eradication, these have to be attended to at once. Large collections, as a rule, have to wait for a more convenient season.

8. The name and full address of the sender should be written clearly on the outside of the package or on a slip placed inside.

9. Letters and packages addressed to the Dominion Botanist, Ottawa, if under 12 ounces, are carried free. There is no limit to the number of packages that may be sent but each must be under 12 ounces.

In addition to specimens being sent up, many requests for information on various subjects were received. A large number of these had reference to the profitable cultivation of medicinal plants. At present, owing to the European war, the price of certain plant drugs is unusually high and some farmers have the idea that larger profits are to be obtained by growing these than can be made from the cultivation of the regular crops. In order to meet these requests for information, a bulletin has been prepared on the subject, and is at present in the press.

Other questions of a miscellaneous nature have been the subject of correspondence during the year, such as the profitable cultivation of hemp in Canada, the growth of the mulberry for silkworms, the culture of wild rice in marshy land, and various other topics.

Seeds were received in exchange from the following Botanic Gardens: Brooklyn, U.S.A.; Siena, Italy; Yurjew, Russia; Sydney, New South Wales, Australia; La Mortola, Ventimiglia, Italy; and the Botanical Gardens, Trinity College, Dublin, Ireland. Seeds were sent out to the following: 37 packets to Sydney, N.S.W., Australia; 70 packets to Manitoba Agricultural College, Winnipeg, Man.; 77 packets to Royal Horticultural Society's Gardens at Wisley, Surrey, England; 15 packets to West Kensington, England; and 16 packets to Royal Botanic Gardens, Glasnevin, Dublin, Ireland.

My assistant Miss Fyles was directed to take charge of the preparation of an exhibit on weeds. For this purpose, sixty-one species of weed seeds, kindly supplied by the Seed Commissioner, Ottawa, were sown May 27 and 28, 1914, in pots and experimental plots at the Central Experimental Farm, for the purpose of studying the early stages of growth of the most common as well as the most harmful weeds in Canada. Specimens of each species were pressed at every important change in the development of the weeds throughout the season. The knowledge of weeds in a young state is highly important to the agriculturist, as it is at this period of growth that they may be most readily and easily controlled.

On July 11, Miss Fyles left for a tour through the West in order to collect flowering specimens of the Western weeds as they are found in their natural surround-

ings. Treesbank, Brandon, Indian Head, Medicine Hat, Lethbridge, Agassiz, Victoria, Lacombe and Rosthern were visited as collecting centres, from which trips were made through the neighbouring districts. Upwards of 800 perfect specimens of weeds representing 44 different species were collected, pressed, dried and shipped to Ottawa, during July and August. Many hundreds of botanical specimens other than weeds were also collected, as opportunity occurred, to be included in the Herbarium. During this trip, it was repeatedly observed that weeds of the worst kinds were allowed to reach maturity on the roadsides and waste places in all directions. This negligence is in a large measure responsible for the constant presence of weeds in cultivated fields.

A demonstration of the life history of 22 different species of Western weeds was prepared for the Central Experimental Farm Western Exhibition circles, each circle showing 14 different species. Each specimen is placed on cotton batting in a shallow cardboard box and covered with glass, which makes a very useful exhibition case.

Exhibition Circular No. 45 was written and 75,000 copies published to accompany this exhibit. The attention of the general public was also drawn to this novel method of mounting weeds by an article in the "Agricultural Gazette."

OTTAWA.

4. REPORT FROM THE FIELD LABORATORY AT ST. CATHARINES.

By W. A. McCubbin, M.A., in Charge.

During the year of 1914, the work of this laboratory has been carried on with increasing success, following out the policy laid down at its inception in 1912, which policy embraced three main features: A general oversight of the district to watch for new diseases and to note the progress of those already present; identification of diseases and advice regarding treatment; experimental work on diseases, which are in need of investigation.

The observations and experimental results which follow partially record the work of the year, but much of the work, including several of the more important investigations, is still incomplete, and it is desirable to defer any account of these till they are finished. A number of minor observations and notes on diseases of less general interest are also omitted.

Owing to the frequent dependence of the spread and virulence of diseases on weather conditions, it was decided early in the year to keep a daily weather record which would contain data valuable to the pathologist, such as the maximum and minimum temperature, periods of drought and rainfall, prevailing winds, etc. The records so far kept have proved useful in so many cases that an effort will be made to make these records more complete and comprehensive than has heretofore been possible.

During the year a large number of specimens have been added to the collection of local diseases and a great many photographs have been made of typical specimens of these. From many of these photographs lantern slides have been prepared, and they have also been of use in supplying illustrations for a bulletin on fruit tree diseases begun in 1913 and completed during the present year (Central Experimental Farm, Second Series Bulletin No. 24).

The universal lack of an adequate general knowledge of the nature of diseases and of the fungi which cause them has become more and more apparent, and an effort has been made this year to partially supply the need by giving addresses whenever possible on the "Principles of plant disease." The matter of these addresses was carefully prepared so as to present the subject in a simple manner and use was made of a series of lantern slides specially made up for the purpose. Twenty-two addresses of this nature were given during the winter and the interest shown in them has been so encouraging that they will be continued and extended during the coming year.

IMPORTANT DISEASES DURING THE YEAR 1914.

APPLE.

Irregular apples.—The ordinary occurrence of small, bunched, mis-shapen apples is well known to be due to the attacks of aphis during the early period of growth, and these have been met with quite frequently all over the country. During the recent summer, however, there came under the writer's notice a form of irregularity that differs much from the ordinary sort and seems to be due to an entirely different cause. The apples in this case were confined to two trees (Greening) in the orchard, which was large, well cultivated, sprayed and pruned. Practically all the apples on these trees were affected and the trouble recurred on these trees year after year. The larger apples

were deeply lobed and fissures extended from stem to calyx, so as to almost divide the fruit into several parts. The smaller apples had these lobes less clearly marked, and had more of a lumpy appearance (see Fig. 5, Plate 4). An examination of the internal structure brought out two facts; first, that there were present an abnormal number of seed cavities; and second, a very imperfect union of the calyx with the gynoecium. In some, a cavity between these two parts could be seen, which extended fully half way around the fruit. In this cavity, there often occurred a white proliferation of the fruit tissue, which consisted of stringy or finger-like growths. Many of the seeds were abortive, especially in the smaller fruits, and the seed cavities were for the most part six in number. It is probable that there is here a physiological derangement of the tree rather than any result of the work of a parasite.

CHERRY.

"Blighting" of cherry shoots.—During the month of July, a number of vigorous, young, sweet cherry trees were observed to have numerous short shoots dying along the main stem and larger branches. The leaves on these shoots died suddenly in a manner suggesting Pear blight. It was found on examination, however, that the longitudinal growth of these shoots was not keeping pace with the wood growth of the stem, so that, when they were carried outwards by the radial increase in stem wood, their vascular connection was torn away from the trunk when, of course, they wilted and died.

Shelf fungus on cherry trunk (*Fomes applanatus* (Pers.) Wallr.)—During the summer of 1914, a dying, sweet cherry tree (Elkhorn) near St. Catharines was found to be suffering from an attack of this fungus at the base of the trunk. There were no wounds evident, but it is highly probable that the fungus obtained a footing in a winter-killed area. As will be seen by the plate (Figs. 37, 38), there is a distinct irregularity near the base where the union took place between the bud and the Malaheb stock, and such irregular or imperfect unions are frequently found to be subject to collar rot. At the time of examination, one half the tree was dead and the foliage on the other part was small and sickly. On cutting down the tree, the white strands of the fungus were found in the wood about this region and extending into the roots. A section of the tree was placed on a tub of moist earth and one of the knob-like growths developed later into a typical shelf, which J. H. White of Toronto University kindly identified as *Fomes applanatus* (Pers.) Wallr.

It is noteworthy that several other trees adjacent to this one have become infested, and may be expected to live but a short time, for once the fungus becomes established in the trunk, there is no means of stopping its progress. In this case as well as in a large number of others, where orchard trees are attacked by this and similar shelf fungi, the only thing that can be done is to prevent the fungus from getting a foothold in the tree. Infection takes place either by spores, which are produced by the shelf growth, or by the filamentous growth of the fungus in the soil, principally on bits of wood and vegetable matter contained therein. As the fungus must necessarily enter the tree through a wound or crack of some kind, it is advisable, especially in an orchard where damage from this cause has already taken place, to make as few wounds as possible on the trunk and large roots, or to protect such wounds as are necessary, or unavoidable, by a coat of paint as soon as they are made. It is also bad policy to allow the shelf growths to mature either on the trees or on stumps about the orchard, since the spores produced on the shelf at maturity are a very efficient means of spreading the fungus to other trees.

Trunk injury on cherry.—A striking effect of winter injury on sour cherry trunks is illustrated in Figs. 31, 32, Plate 9. Similar but less pronounced examples of this

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trouble have been met with in various parts of Ontario, but, in this particular orchard, the damage was quite marked and about fifty per cent of the trees were affected. The cause of the injury may be stated as follows:—

During the severe winter of 1913-14, the cambial or growing region under the bark of the trunk was so severely injured that the bark and the growing layer beneath it were loosened or separated from the main part of the trunk by the death of the tissue just beneath. Ordinarily, when such an injury occurs, enough of the growing layer still remains alive to continue growth and a new layer of wood is added all over the trunk, so that in the years to come the only indication of the injury to be seen is the browning of the heart wood within the trunk. In the present case, however, another factor appeared, viz., a frost crack on one side of the trunk. This crack allowed the loosened but still living outer tissue under the bark to curl outward from the crack on each side, so that, during the following summer, the growth on this side of the stem formed two leaf-like projecting ridges.

CURRANT.

Drooping of currant canes.—In August, 1912, the writer's attention was called by Mr. H. T. Güssow, the Dominion Botanist, to a field of Wilder currants near St. Catharines, in which a considerable number of the bushes showed a drooping of the canes. (See Fig. 25). This field was kept under observation during the succeeding summer, in order to ascertain, if possible, what factor or factors were concerned in causing this drooping.

On June 11, 1913, when the new growth was 6-10 inches long, a large number of the canes were seen to be wilting. (Plate 8, Figs. 26, 27.) In every case there was evident at the bend a blackened area which was usually in the cortex, but sometimes the cells of the pith were affected as well. The bend was not at the soft growing end of the shoot, as might be expected if it were due to lack of water, but occurred about two inches from the base of the new growth. It was suspected at the time that the darkened areas might be due to some parasite, so cultures of the darkened tissue were made under careful antiseptic conditions. Five test-tubes of potato agar were inoculated with this tissue and two poured plates made of the same material all from different shoots. All remained perfectly sterile. Moreover, sections were cut very thin and examined for fungus filaments or bacteria, but no trace of either could be found in any of the numerous transverse or longitudinal sections made. A comparison of transverse sections from the bend of the shoot with those made from the same shoot higher up, after staining with phloroglucin, showed that while a considerable secondary thickening had taken place in the latter, the wood cells at the bend had developed little or none. In addition, the actual amount of woody tissue at the bent portion was little more than half that produced in the higher unaffected part of the shoot.

The later behaviour of these shoots was followed throughout the growing season, and it was found that some of them, about 1 per cent, withered and died, without, however, showing evidence at any time of the presence of parasitic organisms. Those which survived went on growing throughout the summer, the end drooped under geotropic stimulus turning upwards again, so that the final appearance of the affected shoot resembled the letter "S" turned on its side. Fig. 28, Plate 8, is a photograph of this condition at the end of the summer, and it will be noted that in the upper figure the growth of the previous year also shows the same drooping.

Associated with this wilt of the canes, there occurred a striking chlorotic condition of the leaves shown in Fig. 29. This chlorosis, as may be seen from the photographs, occurs in patches, but with a strong tendency to follow the veins. It appeared very early on the leaves and was very prominent at the time the leaves first reached

their full expansion. After that no further development took place, and these leaves remained otherwise normal throughout the summer except that a few of those low on the shoots fell early. The chlorotic condition mentioned occurred on a few upright shoots, but was mostly confined to those which had wilted in the manner just described. Bushes on which wilting did not occur had little or none of it.

Less than one-quarter of the bushes in this field were affected, and on the worst cases the trouble appeared year after year. It was quite bad in 1913, and a number of bushes, which had not been previously affected, showed this year pronounced wilting, and the accompanying chlorotic condition of the leaves. Those plants which are subject to the trouble are clearly less vigorous than others which are free, but aside from this feature and the consequent lessening of the crop, no other functional derangements were observed.

During the fall of 1913, a number of the wilted canes were again examined, and it was found that in nearly every case there existed in the pith at the bend, several brown, dead areas of varying size, entirely disconnected and unevenly distributed along the shoot. In the wilted canes of the preceding year these brown areas were not observed, and there was now no sign in the wilted shoots of last year of their having been present. The photograph of a wilted cane split longitudinally (Fig. 30, Plate 8) shows a typical specimen where four brown pith masses are to be seen—two large ones and two small ones. There was no external indication at this time of parasitic fungi, nor did microscopic examination of the brown areas show evidence of any organism therein. Eleven test tubes of various nutrient media were inoculated with tissue taken from the centre of these brown masses, each from a different mass. They remained perfectly sterile, however, with one exception, which developed a pink bacterial colony, evidently an impurity from the air.

The probability that no parasitic organism is concerned in this drooping of the young growth is strengthened by the fact that it occurs only on the Wilder variety, and that cuttings from these plants also show the same trouble. The only other cases (two in number) observed by the writer are fields grown from cuttings taken from this affected field. Mr. W. T. Macoun, Dominion Horticulturist, does not remember out of his wide experience with bush fruits, any case of the kind on Wilder currants, though he thinks something like it occurs on the Fay. I am informed, however, by Mr. Richard Wellington of the Minnesota Agricultural Experiment Station that he has several times met with this peculiarity on the Wilder currant, but that no parasite had been connected with it.

The probability is that this is another case of varietal weakness. Whether it can be eliminated from the strains or otherwise controlled will require future experiments to determine.

The Currant Polyporus (Pyropolyporus ribis (Schum.) Murrill).

References:—

Saccardo—Sylloge Fungorum, Vol. 6, p. 184.
Tubeuf & Smith—Diseases of Plants, 1894, p. 452.
Engler & Prantl—Die Natürlichen Pflanzenfamilien I, 1**, p. 161.
Bull. Torrey Bot. Club—30: 118 (1903).
North American Flora—Vol. 9, p. 108 (1908).

The information, that may be gleaned from the above authorities and others concerning this fungus, while valuable from a systematic point of view, is scarcely sufficient for the needs of a practical plant pathologist. Descriptions of the fungus are given by most of these authors; it is recorded as occurring commonly on the genus Ribes, but also on the rose, snowberry and other plants; the suggestion is made that in all probability *P. Lonicerae* Weinm. and *P. Euonymi* Kalchbr. are but forms of this

fungus; and numerous localities are mentioned in both Europe and America where it has been collected.

Little has been recorded concerning the nature and extent of its parasitism or the amount of damage it causes, and no means have been suggested for destroying it or preventing its attacks. The remarks which follow are put forward in the hope that they may add something at least to this neglected side of the subject.

In August 1912, the Dominion Botanist, Mr. H. T. Güssow, called the attention of the writer to a field of currants near St. Catharines, Ont., which was affected by this fungus (Fig. 18, Plate 7) and in the intervals of other work a number of experiments and observations were made during the following year.

The field consisted of about a thousand bushes made up as follows: One row of cherry currants, eleven of currants of the Wilder variety, two more rows of cherry currants, and finally several rows of young gooseberries. On examining the field, two facts stood out conspicuously. First, the Wilder currant was the only variety affected, neither the gooseberries, the black currants, nor the cherry currants being attacked in any degree whatever; and secondly, none of the young Wilder plants suffered, but the trouble was confined to the old bushes of this variety. On making a survey of the old Wilder bushes, it was found that out of 550 plants 170, or approximately 33 per cent, bore growths of the fungus. It is probable that the infection percentage was somewhat larger than this on account of the impossibility of including those plants where only subterranean growth occurred.

The bushes in the affected rows were set out seven years ago, but the disease has only been noticed by the owner during the last three years. Since first observed, it has been getting worse each year. So far as can be ascertained, it is the only case of its kind in the neighbourhood, and it is difficult to account for its introduction unless through infection accidentally brought in from some of the less usual hosts in the neighbourhood. None of the plants in the vicinity likely to bear this parasite showed any signs of the fungus whatever, and the source of the infection remains as yet uncertain. On the chance that it might have been introduced with the nursery stock, the plants were traced and the nurseryman written to. He states that he has never seen the fungus among his plants and is quite sure it is not in his neighbourhood.

According to our observations, the fungus only grows on the currant for a distance of six inches or so above the ground and may also grow on roots in the soil to a depth of four inches. All the evidence at hand seems to indicate that the fungus is a wound parasite only, and gains its entrance by way of stubs left in pruning, wounds made by cultivating tools, or the ends of roots broken by the plough. Its non-occurrence on the young plants, as mentioned by several writers and confirmed by observation here, is no doubt due to the absence of a wound of entry on young unpruned bushes. In the many cases examined, the injury by which entry had been effected could clearly be made out, although it was often necessary to cut the sporophore to pieces to determine this point. Location of the wound was made easy by the fact that the tissues of the fungus invariably radiated from this wound. In only a few cases where sporophores occurred clear of the ground did they conform to the typical shape as given in the descriptions. For the most part they consisted of lumpy masses with little or no poriferous surface (Figs. 22, 24, Plate 7). Where these masses form on broken roots below the soil, they are very diffuse and much mixed with earth. Strands can be traced from these subterranean growths out into the soil on all sides, and the manner in which the fungus masses thus gradually intermingle with the earth suggests that a good deal of nourishment must be obtained from dead vegetable matter in the soil. This indication of saprophytic tendencies becomes significant when the relation of the fungus to its host is further considered.

The condition of the various affected plants shows that, for the field in question at least, the injuries brought about by the fungus are not very severe. Several of the largest and thriftiest plants, of which one case is shown in Fig. 18, Plate 7, bore

large masses of the fungus about their bases, and these have been present several years without appreciable effect on their host. None of the plants were killed either wholly or in part, and even a general comparison of plants throughout the field failed to reveal any noticeable difference in growth or bearing between those which were affected and those which were free.

As previously mentioned, the fungus is always associated with wounds, and in all of the many cases examined this wound was found to be healing over normally. The callus, though sometimes slightly distorted by the pressure of the tissue of the sporophore, appeared to be healthy, and the dead tissue was not abnormal in amount. It was apparent that in none of these cases could the Polyporus bring about progressive death or cankering of the tissues to its host, but was quite restricted to the dead portions of the wound.

That the fungus is unable to invade the living parts of its host is shown further by several other features. Cases of recovery were met with where the fungus had died out apparently after having exhausted the resources of dead tissue in a wound; where the wound was above ground isolated from other sources of food supply the sporophore was invariably small in size, or as one might put it, the size of the sporophore was proportional to the dead wood present and not to the size of the stem; the ends of broken roots were often found imbedded in large growths of the fungus, but when cut open the root showed a normal callus and an absurdly small amount of dead tissue at the end; moreover, in sections made of such roots and of the dead tissues about wounds, no mycelial filaments could be seen in any living tissue although such filaments were quite plentiful and evident in the dead parts. All evidence, therefore, goes to show that the parasite is unable to attack the living host. On the other hand, its constant association with wounds seems to indicate that a contribution of some kind must be made by the host and certain features point to the tapping of the sap stream as the advantage derived by the parasite. The texture of the sporophore is such that it absorbs water easily and evaporates it readily, while it differs from most other shelf fungi in requiring a considerable amount of moisture for growth. During the damp season of 1912, vigorous growth took place, while in the summer of 1913, which was very dry, the amount of new tissue produced was very small; hence the probable value of the sap supply as a source of water if not of other substances desirable as food.

Spore cultures were obtained from spores shed from a piece of sporophore inverted over potato agar in a moist chamber for a few hours. The cultures grew well on this medium but very slowly, requiring four or five months to cover the slant surface of an agar tube with its low growing mat of tough light-brown filaments. On peach juice agar and agar made from rat dung, the growth was still slower and the cultures seldom exceeded 1½ centimetres in diameter before the agar dried out. On bean agar, bean pods and carrot plugs the growth was more rapid and more diffuse. Nothing but mycelium was produced in any cultures.

From the rubbery or cork-like texture of the sporophores, it was suspected that they might have a constricting action on the stems which they surrounded (Figs. 20, 21, Plate 7) so as to interfere with the conducting functions. That there was a definite shrinkage of the sporophore tissue on drying out was easily ascertained by comparing measurements of cubical portions in the moist condition and after they had dried. It was found that the lineal dimensions decreased on drying by about 8 per cent, and consequently there was a volume shrinkage of about 22 per cent. On wetting these pieces, they regained their former dimensions. As the tissue of the sporophore is very tough and elastic, the shrinkage on drying would necessarily bring about a considerable pressure on those stems which pass through the mass of the sporophore, a condition of affairs which is of common occurrence as will be seen by a glance at Fig. 21. By way of demonstrating the actual existence of such a pressure, two freshly collected sporophores were perforated by a cork borer and a cylinder of sealing wax of exactly the same diameter as the hole was inserted in each, leaving an inch or so projecting. One was

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kept moist and the other allowed to dry, both at room temperature. In the former, the cylinder was not constricted, but the squeezing effect of the fungus on drying out is unmistakably depicted in the accompanying photograph of the other plug after its removal. (See Plate 7.)

While the effects of this constricting action could be clearly seen on a large number of shoots which passed through sporophores, it was in no case very pronounced, and it is probable that these stems are able to adjust themselves to the pressure so that little interference with their conducting processes results. In all cases the growth above the sporophores was normal and no indications of injury from this source were to be noted.

In the hope of discovering some simple and effective means of ridding the field of the fungus, several substances which it was thought might have the requisite fungicidal properties were tested. The methods used and the results obtained are as follows:—

1. Formalin, 2 per cent.—Pieces of coarse sacking were dipped in a pailful of the solution and then wrapped around the bases of the plants. A light covering of earth was added to keep in the fumes. After a week or ten days the sacking was removed, and the fungus was dead on all the thirteen plants so treated. Many of them were already being attacked by Penicillium and other mould fungi.

2. Ashes.—A shovelful of unleached hardwood ashes was placed around the base covering the fungus thoroughly, and, as before, a light covering of earth was put on to prevent the ashes from blowing away. Four plants were so treated, and the fungus was killed in each case.

3. Salt.—Three plants were treated by sprinkling a handful of common salt on the growths and on the ground close to the stem. The fungus was successfully killed in each case.

4. Corrosive sublimate, 1 in 2,000.—A pint of this solution was used on two plants. The fungus was killed on one but survived on the other. The failure of this powerful fungicide in this case may be due to imperfect absorption.

5. Copper sulphate.—Twenty grams placed where its gradual solution by rain, etc., would act on the affected plants has also killed the polyporus growth in the four plants under treatment.

6. Lime.—Fresh unslaked lime liberally applied at the base of the plants and on the fungus growths was used without success. The fungus is still alive on the four plants so treated.

7. Sulphur.—Ordinary powdered sulphur at the rate of 20 grams per plant was also used without success. It is possible that in this case better results would have been obtained had treatment been given in the heat of summer when it would volatilize sufficiently to have some effect.

In all these cases, the treatments were given in September and the final examinations made early in November so that ample time was allowed for recovery of the parasites, since throughout this period the fungus was growing well on the untreated plants in the field. It was intended to continue these experiments during the summer of 1913, but there was such a scanty and uncertain growth of the fungus owing to the dry weather that further work was deferred till another season.

Summary.

1. *Pyropolyporus ribis* occurred here only on the Wilder currant and only on the older plants of this variety.

2. In the field under observation no serious damage can be attributed to it.

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3. It is a wound parasite which apparently cannot attack the living tissue of its host or even extend the wounds in which it occurs. It apparently obtains only sap from its living host.

4. Of the several substances tried as remedies, formalin, copper sulphate, common salt and ashes gave promising results in the preliminary experiments, while corrosive sublimate, lime and sulphur were unsatisfactory.

GRAPE

Chlorosis of grapes.—Although cases of Chlorosis or yellowing of grape foliage are to be found throughout the district, they are not at all numerous ordinarily in any one vineyard.

The chlorotic condition may result from:—

1. *Fusicoccum viticolum,* which is responsible for perhaps 50 per cent of the cases, or even more.

2. Poor soil, lack of nourishment. In this case, all the vines are more or less unhealthy but a few of the weaker ones may show pronounced chlorotic conditions.

A particular case of (2) deserves mention. Grapes are often grown on the edges of the ravines, which cut through the level alluvial deposit lying below the escarpment. On the level ground above the ravine and on the richer soil below, the vines are healthy, but just near the brow of the slope where the subsoil is nearest the surface and where leaching is most rapid, cases of yellowing are often met with. It is clearly a case of local soil conditions.

3. Lack of iron in the soil. The quick-growing grape sometimes requires more of this substance than is available in the soil during the short period of growth, with the result that the leaves remain yellowish instead of assuming their rich dark green. A row of grapes in a vineyard suspected of lacking iron was treated last spring with iron sulphate, half pound per vine, and this row was markedly improved by the treatment; its foliage was larger and darker and the cane growth more vigorous than in the adjacent rows.

OAK.

Gloeosporium nervisequum on oak leaves.—Oak leaves were found in a number of cases scattered over the Niagara peninsula, in which there were dead areas bearing *Gloeosporium nervisequum.* In some of these trees, 75 per cent of the foliage was badly affected. It is suspected that the leaf areas were first killed by prevalent late frosts, and that the fungus gained entrance thereafter. Many trees were observed in which the same frost burn was present, but which had no sign of the fungus on the dead parts of the leaves.

OLEANDER.

Oleander leaf spot.—Oleander leaves affected by what is taken to be *Cladosporium microsporum* (Fig. 1, Plate 4) were sprayed with Bordeaux mixture and the results indicate thorough control by this means.

ONION.

Botrytis rot of onions in storage.—Large losses are often sustained by grocers and dealers, who handle large quantities of onions, from a soft rot due to a *Botrytis.* Three hundred crates of onions imported from Spain were destroyed in this manner in the storehouse of one wholesale grocer in St. Catharines, and similar cases are reported from other places. Local grocers are sometimes troubled with this disease as well, which, though occasionally seen in the field, is serious only in storage. It is the practice to freeze onions in the fall and keep them frozen until they are to be disposed of, when they are used quickly before the rot can make any progress.

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Cultures of this fungus were made, and it was found to produce both the Botrytis form and the sclerotia readily in culture. The sclerotia only seem to be formed in the onion at low temperatures, but both forms have been frequently found by the writer on onions kept at 40° to 50° F. (Fig. 4, Plate 4). The sclerotia formed in cultures are similar to those found on the bulbs, and are readily induced by cold. Spore inoculations on onions at room temperature (50°—60°) usually produce only the Botrytis form or at least very few sclerotia. On young onions on the market, the Botrytis form has been observed several times, but not the sclerotia.

PEACH.

The Brown rot fungus in mummified fruit.—The Brown rot fungus, *Sclerotinia fructigena* (Pers.) Schroet., is well known as the cause of the common rot of plums, peaches and cherries, and sometimes of apples and pears. Since the fungus in all these cases is a fruit parasite, never attacking the leaves and being found on the branches and limbs to a very limited extent, it becomes a matter of importance to find out just how the infection is passed over from the fruit of one season to that of the next. It is almost certain that on a tree well sprayed in spring the numerous spores which are lodged in the bark, buds, etc., will be entirely destroyed by the fungicide, and indeed it has been claimed that even without the spray very few if any of these spores will survive the winter. We may look, therefore, for spring infection from three sources: (1) From spores brought into the orchard from outside; (2) from the tree "mummies" —those rotted shrivelled fruits remaining on the tree over winter; and (3) from rotted fruit on and under the ground below the trees.

In regard to the first mentioned source, it may be said that the Brown rot fungus is able to live readily on a number of dead vegetable remains and there is a possibility,—by no means remote, that it may survive the winter on these, and produce in spring a crop of spores, which may be carried by the wind and other agencies to the orchard.

In the case of the tree mummies (Fig. 39, Plate 11) there is some uncertainty as to whether spores produced on these in the fall after they have rotted are able to grow in spring after adhering to the shrivelled dry fruit all winter. Attempts made by the writer to germinate these spores in spring gave in a few cases a small percentage of viable spores and in others no growth whatever. This question of held-over spores is of little moment, however, when it is remembered that the fungus remains alive in all these mummies over winter, and in the moist warm days of spring it revives its activity and produces a fresh crop of spores. The writer has tested large numbers of the mummies of plums, cherries and peaches in early spring by placing them in a covered vessel on a moist surface. After a couple of days in a warm room, they invariably produced fresh pustules of the fungus showing that it was still alive within them. There can be no doubt then that these mummies are a real and positive source of Brown rot infection in spring and early summer. The statement is often made by growers that the spring spray ought to kill everything on these mummies. To this a double reply can be made. In the first place, though lime-sulphur is a powerful fungicide for surface use, theoretically it will not kill a fungus in the interior of the mummy Its action is superficial and it dries out before the fluid has had a chance to penetrate. Secondly, there is direct and convincing evidence that spraying is of little use in this case. During the latter part of April and the first of May, mummied peaches and plums were gathered from various orchards in the neighbourhood after they had been sprayed. They were taken from orchards which may be considered to fairly represent the general spraying practice throughout the district, and some of them were from the best sprayed orchards that could be found. These mummies were tested in the same manner as the others, and it was found after a few days that fresh growths of the Brown rot fungus were started on 89 per cent of the peach mummies and on 72 per cent of the plum. In all these tests the lowest percentage obtained was on peaches, 55 per cent, while some gave as high as

100 per cent. There could surely be no more convincing proof offered of the failure of lime-sulphur to destroy the fungus in the mummied fruits on the trees, and I have no hesitation in saying that the only way to avoid the menace of infection from this source is to remove these mummies and either burn or bury them.

There is still the third possible source of spring infection to be dealt with, viz., the rotted fruit lying on or buried in the ground. In this case the infection may arise theoretically in two ways, (1) from the development in spring of a crop of spores such as occurs on the tree mummies, or (2) by the production of the apothecial or spring stage of the fungus (Fig. 41, Plate 11) from the hard black tough masses (sclerotia) in the withered fruits (Fig. 40, Plate 11). In regard to the first possibility—that of the development of ordinary spores from these ground mummies—I may say that it is only in rare cases that this has been observed to happen in spring. It must be remembered that the condition of a rotten fruit remaining attached to the tree is very different to that of one lying on the ground. The fruit on the tree dries up readily, so that the food material is not exhausted in fall and growth continues as usual in spring. A fruit on the ground, on the other hand, is kept much more moist, so that the nutriment is sooner exhausted, after which the fungus forms the tough, black sclerotia already mentioned. Apparently in going into the sclerotial condition, the fungus undergoes some constitutional change, after which it loses the tendency to form the ordinary spores. A culture of the fungus made in December, when it was just entering the sclerotial condition, has now grown for two years without reverting to the ordinary condition in which spores are freely produced. Whether or not this is the true reason, it is certain that the ground mummies rarely form ordinary spores in spring, so that this means of spring infection may be neglected.

We have still to consider the spring or apothecial stage developed from the hard, black sclerotia formed in the ground mummies in fall (Figs. 40, 41, Plate 11). With the advent of warm weather in early spring, there arise from these black sclerotic masses, small, brown, stalked, trumpet-shaped growths, each bearing thousands of spores of a kind quite different from those ordinarily seen on rotten fruit. When the mature, trumpet-shaped apothecia are jarred, their spores are shot from the inside of the cup-like top, and may be seen momentarily as a fine mist. These apothecial spores when grown give rise to the ordinary stage of the Brown rot fungus again.

If, then, this spring or apothecial stage is found to be present in any quantity in our orchards, it would be quite important as a source of the year's infection. In order to determine its prevalence, an examination was made in the spring of 1914 of twenty-five peach and ten plum orchards in the Niagara peninsula. The ground under a number of trees in each orchard was carefully looked over and the presence or absence of the apothecial stage noted. In presenting the results, it should be stated that the figures given are probably below the real values owing to the impossibility of taking into account trees under which the apothecia had not yet developed and also those under which they had matured and vanished. In the twenty-five peach orchards, there were examined a total of 515 trees of which 239 or 46·4 per cent had apothecia present beneath them. Similarly in the ten plum orchards, 229 trees were examined and apothecia found under 181 or 79 per cent. These results are further supported by observations made in 1912 and 1913. In these two years, although no systematic records were made, the apothecia were noted to be quite as prevalent as in the present year. Judging from these three years, therefore, it is plain that the apothecial stage of the Brown rot occurs generally in quite sufficient quantity to be dangerous as a source of spring infection.

The preceding discussion makes apparent the importance of destroying the mummied plums and peaches. As regards those on the tree, it is easy to get rid of them at pruning time by knocking them off, after which the early cultivation usually given in commercial orchards will bury them and thus prevent the formation of spores. In the case of mummies which have over-wintered on or in the ground and have formed

sclerotia, the following points are to be noted, since they have a bearing on the question of the disposal of these mummies:—

1. Those mummies which are buried flush with the ground are in the most favourable condition to produce the apothecial or spring stage.

2. If lying on the surface, they either do not produce apothecia at all or the apothecia are few and small, probably due to lack of moisture.

3. If buried too deeply they also fail to develop the spring stage. Of the numerous apothecia examined, nearly all were from mummies within two inches of the surface, and none were found arising from mummies buried deeper than three inches.

4. The production of apothecia depends largely on a continuous supply of moisture in spring, so that a dry spring or a light quickly-drying soil is unfavourable to this stage of the fungus. Apparently drying out is very damaging, if not fatal to the apothecial stage, once it has started to grow.

5. The season for the apothecial stage includes from the last week of April until about May 24th.

6. The ground mummies, like those on the trees, are not affected by the waste lime-sulphur spray from the trees, and the spring stage is produced even though the mummy has been drenched with spray.

7. Very small bits of the sclerotia are able to produce apothecia.

8. The apothecia are usually produced from the mummied fruits of the preceding year. They may in some cases be delayed for eighteen months, *i.e.*, till the second spring, but the rule is as stated. Large numbers of plum and peach seedlings were found by the writer in 1914 with the apothecial stage growing abundantly from the outer part of the fruit (Fig. 42, Plate 11). As these seeds do not usually remain two winters in the ground before germinating, an interesting confirmation for the rule given above is supplied.

9. The spring stage has not yet been found on cherry mummies.

The obvious method for getting rid of the ground mummies is to bury them deeply, at least three or four inches below the surface, and this may be done at any time in fall or spring before the spring stage begins to appear. Disking appears to cover them at just the right depth for growth, so that this process is of little use in preventing contagion from the ground mummies. Ploughing is much better. For those who have only a few plum or peach trees which are not cultivated, it may be advisable to rake up and burn or bury the mummies so as to lessen infection, especially if the fruit is susceptible to rot. It is almost needless to add that all spraying to control Brown rot should be supplemented by some effort to prevent infection from both the ground and tree mummies.

Injury from cannery refuse.—A case has been investigated where large quantities of cannery refuse were dumped in a peach orchard, the owner allowing it to be done on the supposition that the refuse would have some fertilizing value. However, the whole orchard died the following spring from the excess of acid. The trees were taken out, the land ploughed and next year it was again planted in peaches. No evil effects were seen on the second planting, and it is probable that the greater part of the acid was removed during the summer by the washing of rains or by soil neutralization.

A similar injury to the above, though on a small scale, often occurs where piles of refuse fruit are dumped. A sterile spot in the soil results, on which for a year or so nothing will grow. Such piles should obviously not be put in close proximity to trees.

Peach canker.—The prevalence of the gummosis canker (Fig. 11, Plate 6) of the peach in the Niagara District has led the writer to give this disease some attention during the last two seasons. A great deal of damage has resulted from it, both because of the killing of branches by girdling, and the total destruction of many trees

Fig. 1. Oleander leaves attacked by *Cladosporium microsporum*. Fig. 2. Black Rot of Tomatoes, natural. Fig. 3. Black Rot of tomatoes induced by inoculation with a pure culture of *Macrosporium solani*. Two rot spots and one check are seen on each fruit. Fig. 4. *Botrytis* rot of onion. The outer scales are removed showing the black sclerotia and the gray masses of spores. Fig. 5. Irregular apples. Fig. 6. A typical specimen of the "spindly leaf" symptom of mosaic disease of Tomato.

PLATE LXVII

Fig. 7. Tobacco Root Rot. The rootlets are destroyed by the fungus in all three plants. The centre plant which was taken up in the fall, after growing all summer is yellowish and unhealthy in colour, and has grown only a few inches high. Fig. 8. Ogon plums, which split at maturity. Only a few perfect fruits were obtained from this tree. Fig. 9. Tomato spot or scab. The upper and right figure show early stages and the final appearance is shown in the lower fruit. Fig 10. Spotting of Shiro plums due to *Bacterium pruni*.

Fig. 11. A typical Gum canker on the peach.

Fig. 12. Mummy peaches, from which the Brown Rot fungus has made its way back through the stem to the branch. The area on the branch, which has already been invaded by the fungus is indicated by the dotted line in each case. Cankers sometimes arise from these dead areas.

Fig. 13. An old peach canker cleaned out. and showing the two original fruit spurs by which the fungus gained entrance to the branch.

Fig. 14. A cankered area started about the base of a dead limb. In the second photograph, the same canker is shown with the bark, gum, etc., removed.

Fig. 15. The six cankers shown arose from cracks in the twigs, due to spring frosts. The photograph was made in the following autumn.

Figs. 16, 17. Illustration of the method of treating canker. The first figure in each case shows the canker untouched, the second, the same canker cleaned out and washed with corrosive sublimate 1-1000, and the third shows it again after receiving a coat of paint.

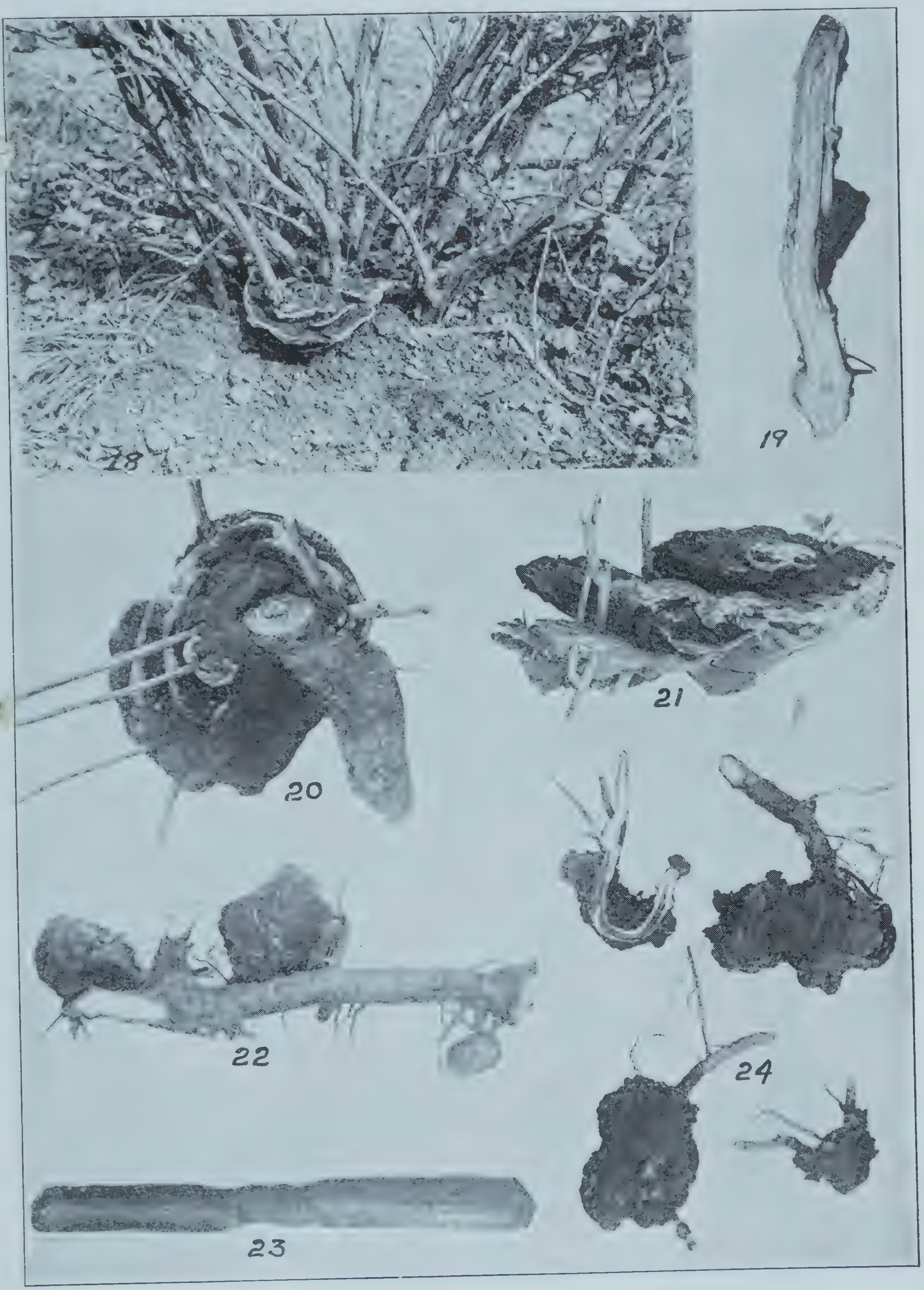

Fig. 18. *Pyropolyporus ribis* at the base of a currant bush.
Fig. 19. A very small sporophore growing on a wound above ground. The branch is split in two.
Fig. 20, 21. Typical sporophores of *P. ribis*.
Fig. 22. Large lump masses of *P. ribis* growing on an underground root.
Fig. 23, Sealing-wax plug constricted by the drying of a piece of *P. ribis* through which it had been inserted while the tissue was still moist.
Fig. 24. Masses of *P. ribis* growing on roots beneath the surface.

Fig. 25. Typical case of drooping of canes on Wilder currants. Figs. 26 and 28. Fig. 27. Several branches showing the characteristics of the drooping. The upper figure in 28 shows the effect of two consecutive seasons of wilting. Fig. 29. Leaves from the affected plants showing the peculiar chlorotic condition associated with the drooping. Fig. 30. An affected cane split so as to show the brown areas in the pith.

Winter injury on cherry trunks. The result of a frost crack down the trunk associated with the destruction of the tissue within the growing region by severe cold.

Figs. 31, 32. Photographs of the trunks as they appear the fall after the injury.

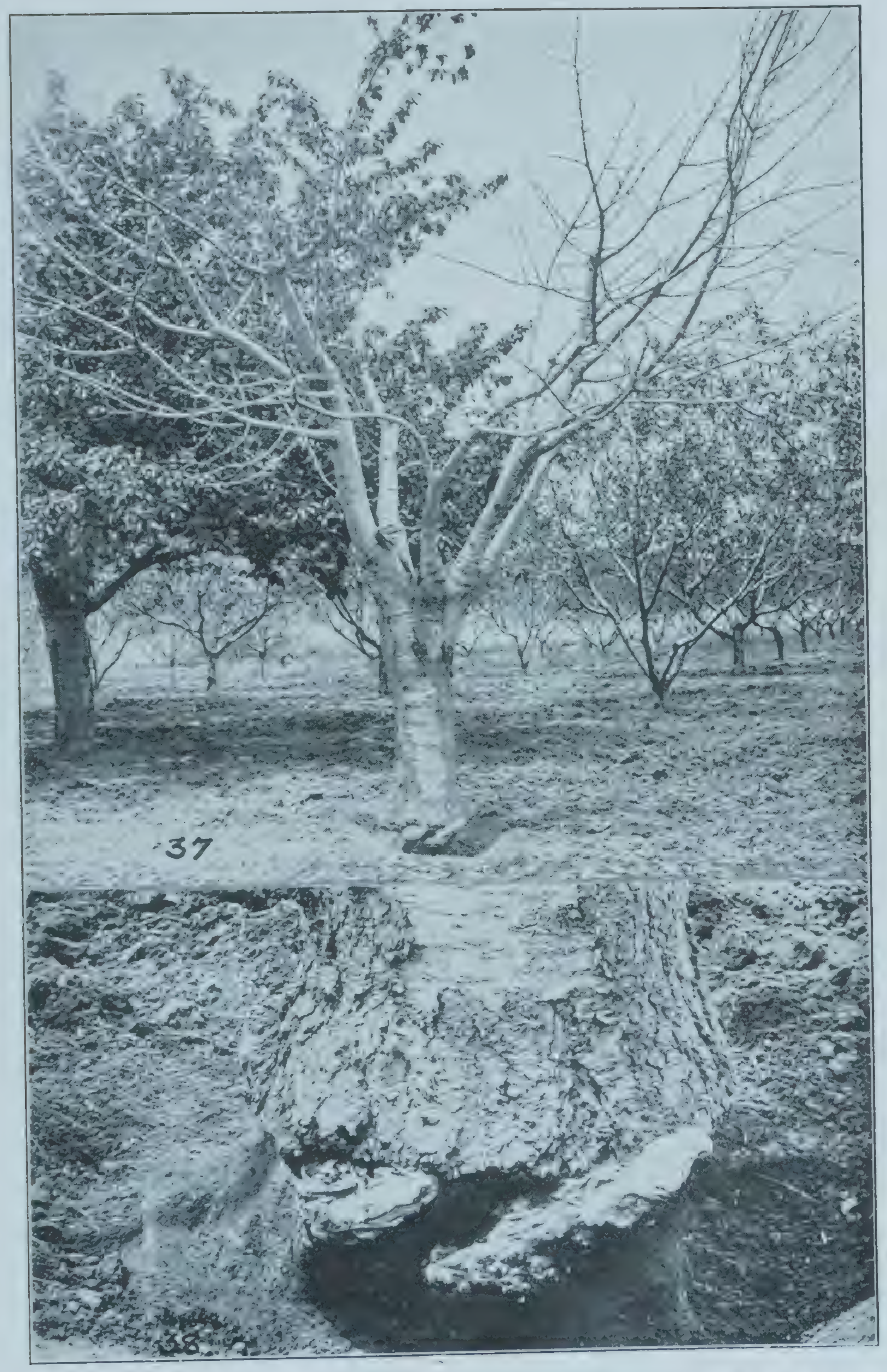

Fig. 37. Shelf fungus (*Fomes applanatus* (Pers.) (Wallr.) on cherry. Fig. 38. The lower photograph is an enlarged view of the trunk, and shows the knob-like fungus growths at the irregular graft union.

Plate LXXIII

Brown Rot on peach and plum mummies.

Fig. 39. A mummied peach adhering to the tree over winter.

Fig. 40. Sclerotia formed on fallen peaches. These black tough masses form in the fall, and in spring give rise to the apothecial stage of Black Rot.

Fig. 41. Cup-like or goblet-shaped apothecial stage growing from peaches over-wintered on the ground.

Fig. 42. Brown Rot apothecia on a plum seedling.

where cankers attacked the trunk. The crotches where the main branches join the trunk are often the seat of trouble, and an active canker in this region soon eats completely around the stem and kills the tree.

Numerous other trees are known to be affected by similar canker troubles, and as a great many of these are known to be due to the action of fungi, there is a strong probability that those of the peach have a like cause. Among others, Jehle in 1912 has published a paper on the subject, in which he attributes these cankers on the peach to the work of the Brown rot fungus (*Sclerotinia fructigena*). He has obtained this fungus consistently in cultures made from the tissue of cankers, and has succeeded in inducing cankers by inoculation of healthy peach limbs. An important point of evidence, which further connects the Brown rot fungus with canker, is in the tendency to canker formation at the base of twigs killed by the Brown rot, which has made its way down the twigs from mummied fruits remaining on the tree (see Figs. 12, 13, Plate 6). A certain proportion of cankers arise in this way, but they may also have their origin at the bases of twigs killed by other causes, or at wounds made in pruning, or even under the unbroken bark, where the possibility of parasites being the cause is very small. Moreover, cultures made from such recently formed cankers, where the bark was yet unbroken, remained invariably sterile. Even from older cankers, cultures made in this laboratory gave several fungi, but Brown rot was rarely present.

Besides these discordant details, there are certain other features which seem to indicate that Brown rot is not the only causal factor, or at least, that there are other contributory causes. In the first place, peaches have been grown in the Niagara peninsula for over forty years as a commercial crop, but it is only since the year 1908 that the canker has become noticeably abundant or indeed common. Many orchards twenty to thirty years of age still exist, and the present condition of these bears out the assertion of the older growers that, up till the time stated, there was little or no canker in our peach orchards. Brown rot has, of course, always been present, and it seems strange, if it alone were the cause, that cankers should not have been prevalent until recent years.

Again the occurrence of canker in more or less localized areas is another feature of the disease that Brown rot infection can scarcely explain, and it is to be noted that high and well-drained land is exceptionally free from canker troubles, although they have their full share of Brown rot on the fruit. The level alluvial stretch of land lying between the escarpment and Lake Ontario contains the orchards worst affected, while the higher and more broken lands about Stamford and Fonthill are comparatively free from canker.

Observations made by the writer seem to indicate that excess of water in the tree is favourable to canker, and that the lack of air, drainage, as well as superabundance of soil moisture are to be considered. In both respects, the highlands have the advantage over the level land below the escarpment. In this connection, it may be noted that the rapid extension of cankers takes place in spring when moisture in the tree is at its maximum.

There is still another factor, which it may be necessary to take into account in settling the cause of canker, viz., the effects of winter. The irritation of the canker stimulates the growth of an abnormal callus tissue around it, and an examination of this growth during the fall shows that its cambium is still active long after the ordinary growth of the tree has ceased. Such immature callus tissue is extremely liable to be killed by the low temperatures of winter, and the canker is extended in the spring. In another note, contributory evidence on this point is presented, and it is there pointed out that the tissues of a newly-formed canker, or the tissues at the edge of an older one, are strikingly similar to the tissues in a typical frost injury. There is the same browning of the wood cells and the same formation of gum cavities, both of which features differ materially from the conditions found in an ordinary clean

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wound. It is possible that the origin of those incipient cankers found under the unbroken bark may also be due in some measure to winter injury, and that in other cases the same cause may materially contribute to the increase in size of cankers already formed.

No other means can be recommended for the treatment of cankers than removal of the gum and dead wood and then washing with corrosive sublimate 1-1000, or Formalin 2 per cent, after which a protective covering of paint, or some very adhesive whitewash will ensure the cleanliness of the wound for a long time. Figs. 16, 17, Plate 6, illustrate the method, and they have given good results wherever intelligently carried out. It will not pay to apply such treatment to all cankers on the tree, but in the case of those around the trunk and main limbs, which threaten the safety of the whole tree, it will pay many times over. One of the greatest losses from canker arises from the breaking down of branches in the stress of a storm, or from the weight of a crop, because the heart-wood at the canker has been weakened by rot. The course of treatment advised above keeps this wood sound until the limb has been strengthened by new growth.

Peach canker arising from frost cracks.—In the spring of 1912, there occurred several frosty nights at the time when the peach buds were swelling. In most cases, no injury followed to either fruit or foliage, as the temperature fell only a few degrees below the freezing point. In a few trees, however, which appeared to have started somewhat earlier and were therefore filled with sap, these frosts caused the twigs to split and the buds to burst from them. The injury was purely mechanical and was evidently due to expansion in freezing of the excessive amount of water in the tissues. Less advanced trees were uninjured, and all the buds on the injured trees, which were not forced off by the ice, were quite unhurt. One of these trees which was watched throughout the summer bore a heavy crop of fruit, for in it the injury was mainly confined to the sappy centre shoots.

In a few days after the injury the cracks in the twigs began to exude copious masses of gum, and sections of such twigs made at this time showed the presence of gum cavities in the wood at each side of the cracks. The general condition of the tissues at this stage bore such a striking resemblance to the features found in an ordinary canker, that the question naturally arose: Is frost injury not sometimes a contributory cause of canker?

It is somewhat significant that on the tree in question, numbers of these twig cracks later on developed typical cankers, which, before summer was over, had girdled and killed their respective shoots (Fig. 15, Plate 6). It is not intended to exclude in this case the possible later infection of these cracks by Brown rot or other fungi. Such infection was extremely liable to occur, but even if the production of the finished canker is attributed to the action of fungi infesting the crack later in the spring, such an assumption does not invalidate the conclusion that the frost in this case produced not only a wound, but a wound of such a nature as to be favourable to the formation of a canker, and exhibiting the pathological features of the tissues found in ordinary cankers. As mentioned in another connection, there is some ground for suspecting that the killing of soft or unripened tissue by freezing may be a contributory factor in the annual increase of old cankered areas, and the behaviour of the twigs split by frost is confirmation of that suspicion.

Germination of peach pits from yellows trees.—It has been contended by many nurserymen that pits from diseased peach trees are not capable of germination and that, therefore, there is no danger of introducing the Yellows and Little Peach through the seedling stock used in budding A good deal of divergence exists among the results of various investigators who have tested diseased pits, so it was considered advisable to make further tests with locally produced seeds. One thousand two hundred pits were taken from fruit of badly diseased trees, and these pits were buried over winter in six

inches of soil. In the spring they were cracked and without allowing them to dry out, they were planted in rows in light but fertile soil. Of these, 8 per cent grew and produced seedlings perfectly healthy in appearance. Concurrent experiments by Mr. L. Caesar, Provincial Pathologist, carried on in a similar way, but with pits from other sources, gave also between 7 and 8 per cent of germination.

These results show that where home-grown seed is used for nursery stock, there is some danger of the disease being carried into the orchards by means of infected nursery trees. The seedling trees at the age of two years showed no sign of disease.

Cracking of peaches.—A good many Crawford peaches were noted during the peach season, in which a large crack had developed at the stem, often extending into the pit which was also split open. Sometimes gum was produced in these cracks, and in many cases fungi had invaded them, rendering the peach somewhat unsightly. The Macrosporium so constantly associated with Brown rot on mummied peaches was the most prominent of these fungi. The cracking, it is believed, resulted from rapid and unequal growth of the fruit in the warm, moist weather, which succeeded the pronounced mid-summer drought.

Winter injury to peach buds.—The winter of 1913-14 will long be remembered by the peach growers of the Niagara peninsula as the year of the "Big Freeze." Never before in the history of the local peach industry was there such wide-spread failure of this crop. Only a few orchards bore fruit at all, and these in small quantities, while hundreds of others had from a few dozen peaches down to absolutely none.

In such a remarkable year, it is well to carefully note the various factors which resulted in this failure, and to lay by for future use whatever lessons may be gained therefrom.

The fall of 1913 was characterized by an abnormally high temperature, which also persisted long into what should have been the winter period. There were a few slight frosts, but in general the ground remained unfrozen until January 15. Although wood growth did not occur to any extent on account of this open weather, the fruit buds developed far too much and consequently were in no condition to meet severe cold. Within a few days after this date, the temperature fell to nearly 15° F. Afterwards a period of milder weather set in, followed by a second and more extended cold wave in February. Although the actual records are not available, it would seem that the temperature did not fall much if any below the danger point which, for the district, is considered to be about 15° F. Owing to the tender condition of the buds, however, and to the suddenness of the attack, the results were disastrous to the peach crop.

Besides the destruction of the fruit buds, other injuries due to severe winter conditions were found to be much increased in number. Twig killing or "Dieback" was noticeably more pronounced, and a larger number of trees than usual died of Collar rot during the ensuing summer. Heart brown of the wood also occurred in a large number of orchards.

All these losses, however, were quite insignificant compared to the destruction of the peach buds, and any lessons that may be learned are particularly valuable in so far as they give hints as to means by which future protection may be secured. It is unfortunate that the injury was so universal as to give fewer means of comparing the advantages and disadvantages of different conditions, than a less complete destruction would have allowed, but there are still a few clear and outstanding features which are worthy of consideration.

In the matter of varieties that escaped, there is little to be said, as there was a great lack of uniformity in this respect. Probably on the whole Elbertas suffered most, while a list of the varieties that survived would include E. St. John, Longhurst, Early Rivers Fitzgerald, Triumph and one or two others. Seedling trees were in several cases noted to be less injured than the ordinary budded stock. The severity of the freezing was such, however, that any extended comparison of varietal resistance was impossible.

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Again there were several orchards or small districts which escaped complete destruction and bore a small crop. In such cases, nearly all varieties were represented, although those in the list given above were least injured. Such small areas occurred at Queenston, St. Davids, Fonthill and Grimsby, with a few scattered orchards and individual trees elsewhere. In some of these cases it is very difficult to account for the freedom from injury, while in others the favouring factor can be readily seen.

In one or two cases, proximity to the lake seems to have been responsible for some slight immunity, but this was of such small general importance as to be negligible. The chief factor in the escape of both individual trees and of orchards seems to have been good soil drainage, which gave dry conditions during the fall and retarded the development of buds. Dulverton orchard at Queenston and some Fonthill orchards are examples of this. In the former, the soil is a coarse and deep gravel draining into the Niagara river; in the latter, the land is hilly and the soil a deep, sandy loam. There are numerous individual cases which confirm the view that the presence of too much water rather than extreme cold was the prominent factor. In several cases, limbs broken down but still attached to the tree bore blossoms while the rest of the orchard was blank. In one orchard parcelled out in building lots, several trees, which had been cut off in the lots and left for two years weed grown and uncultivated, bore blossoms and set fruit, while the rest of the orchard had nothing. Cankered limbs seemed to survive better than healthy ones, and weakly trees were surprisingly safe, presumably because their buds were less advanced than those of their vigorous neighbours.

Some protection was afforded in certain instances by snowbanks which covered a limb or part of it, and a few trees in protected garden orchards in the town of St. Catharines bore a small crop.

It may be that very little can be done to protect an orchard from a winter such as this, but it is probable that, where we have to undergo one such winter, we shall have twenty others less severe in which a little protection will be valuable. The evidence shows that every means that can be used to dry out the soil in the fall, and thus retard the development of the fruit buds, tends to secure safe wintering. The various means that may be adopted for this end include:—

1. Thorough drainage, by under-drains, if necessary.
2. Avoidance of late cultivation which retains soil moisture. It is advisable to cease cultivation as soon as enough moisture to develop the crop can be assured.
3. Cover crops can be planted to advantage. They take up and evaporate the soil water and also temporarily retard the growth of the tree by taking up some of the readily available food material.

PEAR.

Pear blight epidemic.—During the spring of 1914 this disease, variously known as Pear Blight, Blossom Blight, and Fire Blight, attained the importance of an epidemic in orchards throughout a great part of Ontario, and in not a few cases caused immense damage. For the better understanding of a discussion of the causes which led up to, and favoured the excessive development of the disease this year, it may be valuable to note first a few of the outstanding features of the Pear Blight disease.

It is caused by bacteria, which infect the soft or sappy tissues of apple, pear, and quince trees, and which destroy the blossoms and young fruit (Blossom Blight), twigs (Twig Blight), leaves and shoots (Fire Blight), or limbs and trunk (Body Blight). Usually all the bacteria in an affected limb die during the winter, owing to the drying out of the tissues, but in a few cases they remain alive, and it is from these that infection starts again in spring. The infection is spread to the blossoms mainly by insects, and when a few blossoms are infected the bees readily spread the organism to other trees and to other orchards. The bacteria develop very rapidly in the blossoms, and

these are killed, after which the organism works its way down into the twigs and limbs, killing them as it progresses. In apples and quinces, there is usually nothing more serious than blossom and twig destruction, but in pears, and especially in susceptible varieties, large limbs and even whole trees are destroyed.

The means adopted to control Blight in pears involve (1) cutting out thoroughly and remorselessly all blighted limbs in winter time, and (2) regularly inspecting the orchard during the summer and taking out all blighted parts, taking care to cut well beyond the apparent limits of the disease. It is necessary to cut from six inches to a foot below the apparently diseased part because the bacteria, in summer at least, have usually advanced much farther within the limb than is indicated outwardly by the black and shrunken bark. It is probable that when the bacteria have ceased to advance rapidly, as might be expected in late fall and winter, the blackening and shrinking of the bark more nearly keeps pace with the progress of the organism within, and for this reason it is not necessary in winter pruning to cut so far below the apparently diseased area as in summer pruning. In Text Fig. 1, there is shown diagrammatically the difference between the summer and winter conditions in this respect.

With the above outline of the disease by way of preface, a few remarks concerning the epidemic of 1914 may be now made. In reviewing the situation, it is necessary to go back to the fall of 1913, which, it may be recalled, was exceptionally mild and more than usually moist. Because of these weather conditions, the trees did not dry out sufficiently to cause the death of the bacteria in the blighted limbs then existing. In consequence, there were far more of these limbs than usual in which the bacteria were safely wintered. It should perhaps be added that the numbers of such blighted limbs were not reduced, as they should have been, owing to neglect and lack of vigilance at pruning time, so that in the spring of 1914 the sources of infection were far more numerous than in ordinary seasons.

During the spring weather conditions again helped the disease. The weather record at blossoming time shows a period of fine, bright, calm days—ideal weather both for the development of the bacteria in the nectar of the blossoms, as well as for the activity of bees, which were thus able to spread these bacteria thoroughly all over the orchard. Doubtless other insects also played a part in inoculating twigs, leaves, and blossoms, but evidence as to the work of bees is clear and unmistakable. The general result was wholesale inoculation of apple, pear, and quince blossoms. With regard to apple and quince, there was comparatively little damage beyond the blossom and twig blight, and its consequent effect on the crop, but the infections on the pear progressed from these initial points in a way that was disastrous.

Here again for the third time weather conditions were on the side of the disease, for all spring and summer up till the end of June were so wet that moisture in the tree was plentiful, and the growth consequently was soft and sappy, thus presenting the very conditions favourable to the growth of the bacteria within the limbs. During this period, even in Kieffer pears, which are to some extent resistant to limb and trunk blight, the disease made discouragingly rapid progress, and large limbs and whole trees were destroyed. In more susceptible varieties such as Bartlett, the damage done in some orchards was irreparable.

It may be that only an occasional year will bring such an epidemic as this, but there is no doubt that, when weather conditions are again favourable, the same thing will happen in due course. We cannot control the weather, but the course of this epidemic points out in a very striking way the necessity of eliminating from the orchard during fall and winter every bit of blighted wood which might carry live bacteria over into the succeeding season, and which might in this way be the focus, so to speak, from which widespread destruction might develop.

Sunburn on pear foliage.—In common with a number of other trees, both wild and cultivated, occasional cases of sunburn were met with on pear foliage. No serious

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Text Figure 1.

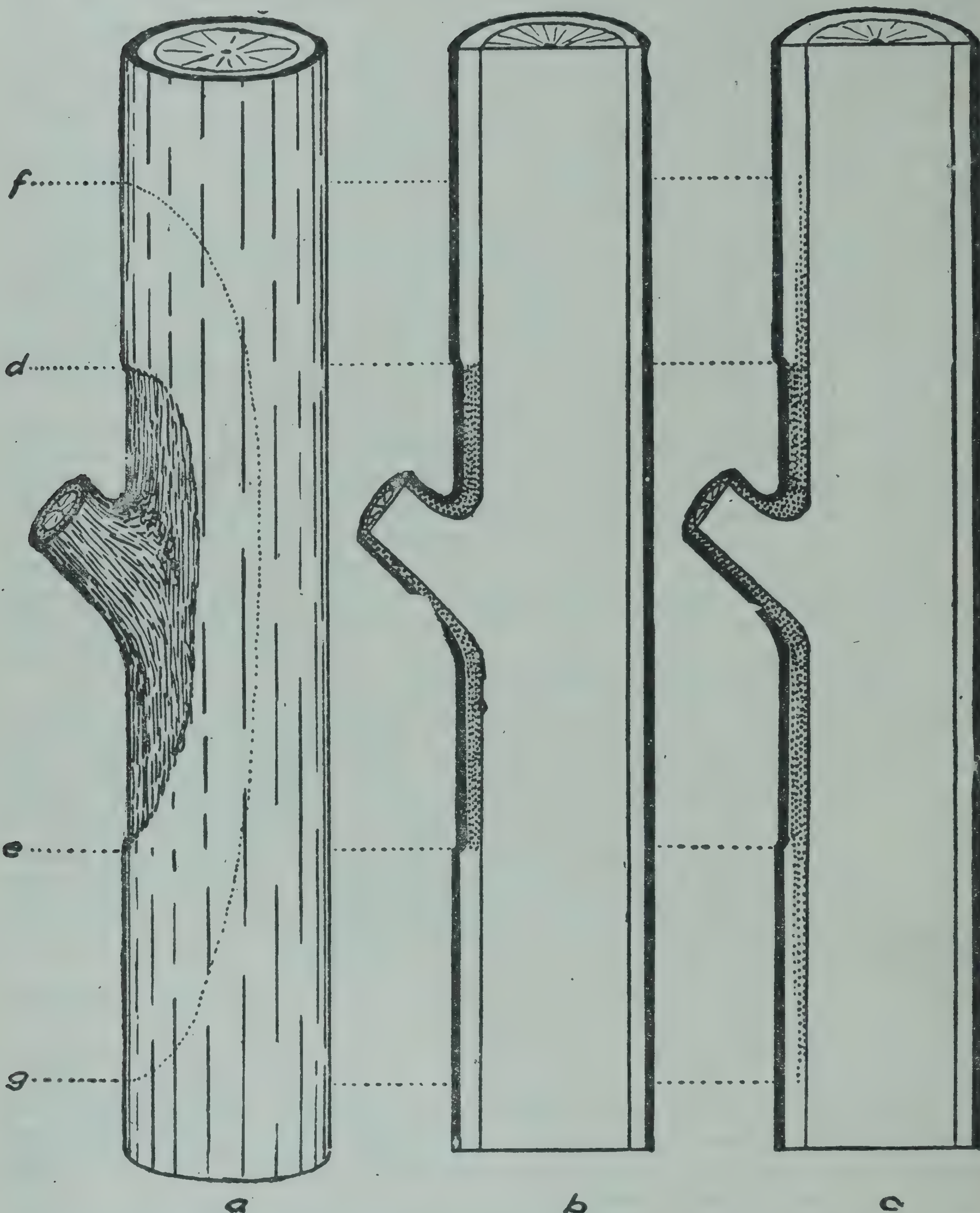

Diagram of branch of pear affected by Blight.

a. Exterior view showing darkened and shrunken bark (*d*-*e*).

b. and *c.* Sectional views of same branch (*b* in winter, *c* in summer), the bacteria indicated by dotting.

In cutting out the blighted area shown in *a* in winter, a cut between *e* and *g* would be below all bacteria. But in summer pruning a cut between *e* and *g* would be right into the infected area as seen by a glance at *c*. In order to get below the bacteria in summer, it will be necessary to cut below *g*, or, in other words, 6 inches to a foot below the apparent limits of the diseased area.

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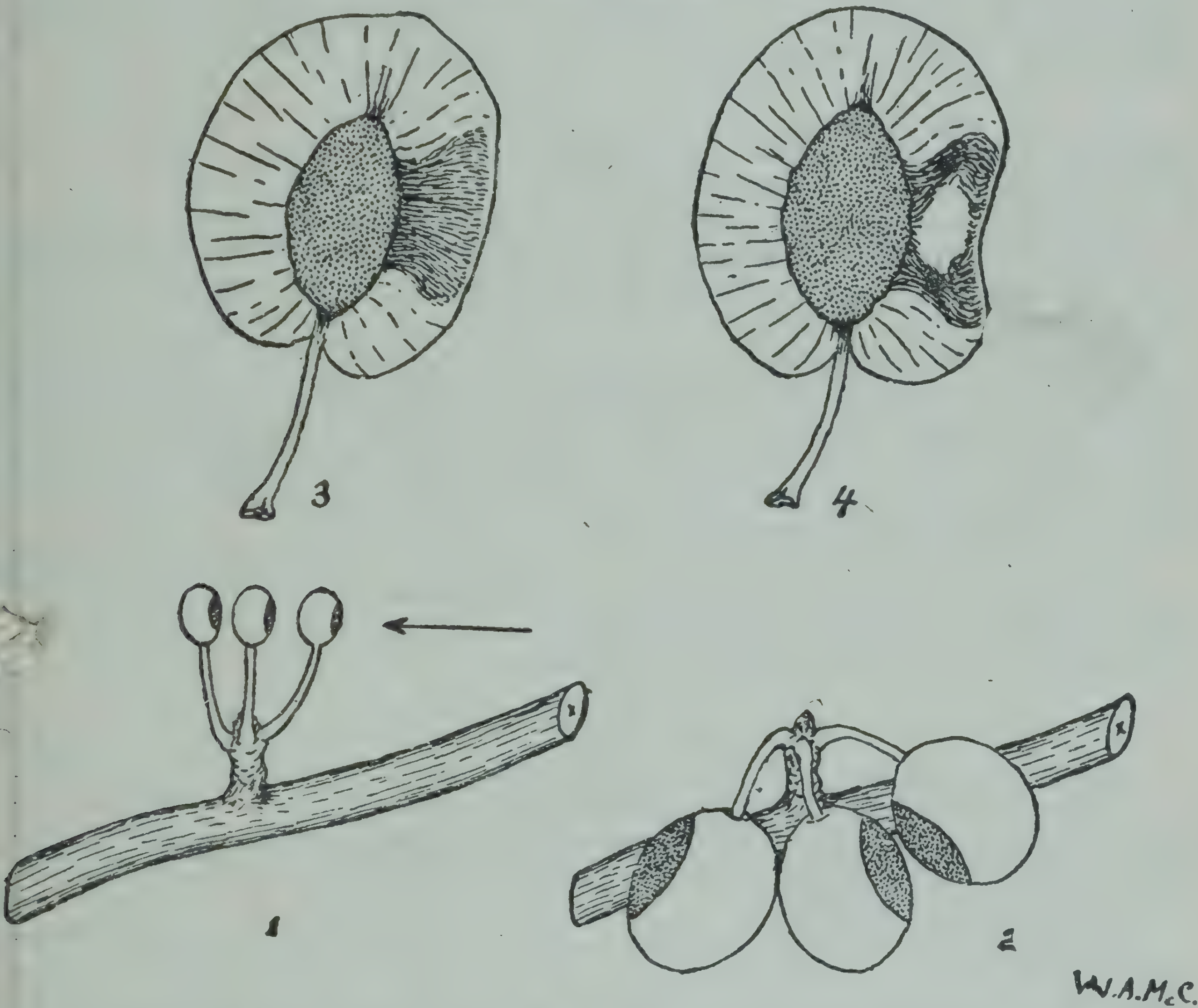
damage was done in any case, but such injury is liable to be mistaken for the work of the Blight organism. One point of difference was noted, which helps to distinguish the sunburn from Blight. In cases of sunburn, there are usually some leaves slightly injured, and it will be found that these have the dead areas between the veins. In this as in other cases, the sunburn resulted from hot and dry weather following a moist period, wherein the leaf growth was rapid, soft, and unresistant to drought.

Text Figure 2.

Sun Scald on "Omaha" Plums.



1. Young plums at the time of injury.—The dark spot indicating the injury is on the south side, the arrow showing the direction of the sun's rays.
2. The same three plums later.—In drooping over the spots were in some cases turned away from the sun.
3. Section of an affected plum.—The brown scalded area is indicated by dark shading.
4. A more severely injured fruit.—In this case the brown tissue has collapsed leaving a cavity.

PLUMS.

Sun scald of plums.—During the summer of 1914, attention was called by F. M. Clement to a peculiar spotting of Omaha plums at the Vineland Horticultural Experimental Station. These plums were large and well shaped, but a large proportion of the fruit on the two trees of this variety developed dark tissue in the flesh on one side at maturity. On the surface the skin was unbroken but the area above the spot was

depressed slightly and minutely pitted owing to the collapse of the lenticels. A diagram of a section of an affected fruit is shown in Text Fig. 2 (Fig. 3). The brown tissue extends in wedge fashion from the skin to the pit, and in some cases this dead portion has collapsed leaving a cavity (Fig. 4). No fungus filaments were found in any of these fruits, nor did the browned area extend when the plums were kept in a warm room for over a week. Test tube cultures of the affected tissue remained sterile. From the fact that the great majority of these spots were found on the south or southwest sides of the fruits, it is considered that this spotting is a form of sun scald (Fig. 1). The fact that in some cases the spots were on a surface not directly exposed to the sun does not necessarily conflict with this view. The dropping of the fruits when increase of weight took place would obviously bring about a change in orientation with reference to the southern exposure as illustrated in a diagrammatic way in (Fig. 2).

Such an interpretation would indicate that the injury must have occurred at a comparatively early stage, and it is interesting to note that the weather record is in agreement with this view. June, 1914, was cool and moist, but was succeeded by a hot dry July, thus presenting ideal conditions for an injury of this nature.

No variety other than the Omaha was affected in this orchard, but it is probable that a number of other varieties might suffer in this way, when the weather conditions are favourable.

Splitting of plums.—Several cases have come under notice where Japanese plums principally of the Ogon variety have developed splits in the fruit at or near maturity. The splitting extends uniformly from the stem and around to the opposite or style end in meridian fashion, and the fissure ordinarily reaches halfway to the pit. (See Fig. 8, Plate 5.) In several orchards this variety has been entirely discarded because of the impossibility of getting perfect fruit.

Bacterium pruni on Japanese plums.—This parasite has been met with in only one orchard in the peninsula on Japanese plums (Shiro). Several other varieties were slightly affected but from 20 per cent to 30 per cent of the Shiro fruits were more or less spotted by the disease (see Fig. 10, Plate 5).

RASPBERRY.

Raspberry cane blight (*Coniothyrium Fuckelii.* Sacc.)—This disease was present in a number of fields in the district, but was particularly severe in one field of the Gregg variety, and Bordeaux mixture was tried on this field. Careful sprayings were given on the following dates: 1912, November 20; 1913, April 21, May 6, May 31, June 23, August 19, September 6.

During 1912, the old canes had been allowed to remain until October 26, but in 1913 they were taken out on August 15, shortly after the last of the crop was picked. In 1912 only half the field was sprayed, but, beginning with August 19, the whole field was treated. In spraying, care was taken to cover every part completely, and to thoroughly drench the old cane stubs at the earth's surface.

In spite of the number of these sprayings and the care exercised in their application, no benefit whatever resulted and the blight was just as bad in the sprayed as in the unsprayed portions.

The infection of the young canes was carefully watched for, and, though the old canes began to die from May 15 on, there was no sign of blight in the young growth till the first two weeks in July. Infection occurred in the following ways:—

1. Through the pruned ends of young growth topped to encourage side shoots. This was by far the most common means of infection.
2. From dead leaf stalks on the stems.
3. From small wounds such as thorn scratches, etc.
4. From one cane by way of the underground stalk to an adjacent cane.

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STRAWBERRY.

Botrytis rot of strawberries.—A number of strawberries showing bleached soft watery areas have been examined. In all of them, fungus filaments were present in the soft-tissue. Test tube cultures from such tissue invariably gave a *Botrytis* growth, and affected fruits kept in a moist chamber developed external growths of *Botrytis* in a few hours. In the field, this rot was found to be present on fruits in all stages of ripeness and half-grown berries were frequently seen shrivelled up and covered by the same fungus. The rotting of the fruit was serious in one or two fields. It was most severe in conditions of high humidity, especially where weeds had been allowed to grow, and thus retain air moisture during the day. During a few days of warm and very damp weather, there was a great deal of the rot in the two fields mentioned, but it almost disappeared during the ensuing hot and dry period.

SWEET PEA.

Mosaic of sweet pea ("Streak").—This disease was found to be prevalent in an Ontario greenhouse in the winter of 1912-13, and was so general among the plants that a good deal of loss resulted. The origin of the infection cannot be explained. Efforts were made to inoculate the disease, as is readily done in the case of tomato and tobacco mosaic. The juice from the macerated leaves of diseased plants was injected near the growing points of ten healthy plants growing in the laboratory, for which purpose a fine-pointed hypodermic needle made of drawn glass tubing was used. The inoculation was again performed in a similar way after two weeks' time, but the plants reached the flowering stage and died without showing any signs of the disease. Mr. L. Caesar, the Ontario Pathologist, in similar inoculation experiments concurrently carried on, found the disease transmitted in this way, but only a small number of his inoculations were successful.

As additional tests, seeds from affected plants were sown in clean soil and seeds from clean plants in soil taken from the diseased beds. In both cases, the resulting plants matured and blossomed without showing disease.

From observations made in the greenhouse in question, it seems probable that, as in the case of the tobacco mosaic, the disease is spread from plant to plant by insects.

TOBACCO.

Tobacco root rot.—The tobacco fields in Essex County, Ont., have for some time been troubled with the root rot (*Thielavia basicola* (B. & R.) Zopf.), which has spread to such an extent as to seriously affect the crop over large areas. This disease is well-known in the tobacco regions of the United States, and no satisfactory remedy has as yet been found for it. Fig. 7, Plate 5, is a photograph of the roots of three plants in which the disease had been at work throughout the season. The rootlets are destroyed as fast as they are formed, and when the plant is pulled up the rootlets break off very easily. An examination of the root system of a diseased tobacco plant will show that the rootlets are dark, dead and discoloured. The root rot does not kill the plants outright, but retards their growth so much that they are worthless. The top has been left on the central plant in Fig. 7. The leaves on it are small, yellowish and sickly, and, although this plant had been in the field all summer, the top had made only a few inches of growth during the season.

TOMATO.

Mosaic disease of tomato.—This trouble was found in several fields in 1912, and in three of these it was so bad that some attention was given to a study of the disease during the following summer, mainly to determine, if possible, what factors are involved in its occurrence and spread under field conditions

St. Catharines.

Symptoms.—Mosaic may be recognized readily in the foliage, especially in the younger leaves. These have either patches of light or yellowish-green interspersed throughout the normal dark green of the leaf, or in the case of worse affected leaves, the greater part of the leaf surface may be of the lighter colour and the normal dark green areas appear in patches. Since there is a tendency for the dark green areas to grow more rapidly than the sickly yellowish portions, the dark green normal tissue will often be found blistered and distorted from being thus cramped and confined by the surrounding yellowish areas. There is also a tendency in mosaic plants to produce narrow leaves, and, in some extreme cases, the leaf surface is so reduced that the plant becomes almost grass-like in character. The name of "Spindly Leaf" is most appropriate for this feature of the disease, and the appearance of such leaves is illustrated in Fig. 6, Plate 4. "Fern Leaf" is another form of mosaic leaf growth occasionally met with, in which a large number of small leaflets arise from the main rib instead of the few large leaflets found in the normal leaf. Neither "Spindly Leaf" nor "Fern Leaf" are common in the field, the normal form of the disease being the true "mosaic" or patterned leaf described above. The mosaic symptom has been recorded as occurring on the fruit, but has never been met with by the writer. Whether because of the mere weakening of the plant, or through some direct activity of the disease, the blossoms on affected plants often do not mature, and hence there is a smaller setting of fruit on them than on healthy plants. Ordinarily this is of small consequence, as, on slightly affected plants, a sufficient number of blossoms are left to ensure the crop, but when plants are badly affected, there is a marked lessening in the number of fruits set as well as in the size of the fruit. Cases of "Spindly Leaf" set very few fruits, and even these remain small, so that such plants are worthless. In the three fields previously mentioned as being badly diseased, the loss due to the disease was estimated at from 20 per cent to 50 per cent.

Extent of the disease.—Beyond the examination of a few diseased fields, no data were obtained regarding the prevalence of mosaic in 1912, but in 1913 there were examined sixty-one fields, out of which 15 (or 26 per cent) had the disease present to a greater or less extent. In none of them was it so serious as to cause great damage, and in many cases only a plant here and there was affected. No fields were met with, which had an infection approaching that of the three observed in 1912. It is possible that seasonal variations affect the virulence of the disease, but several years of observation are necessary to establish this point.

Infection. A consideration of the factors that might be involved in the maintenance and spread of mosaic leads to an investigation of the following possibilities:—

1. Does the disease remain in the soil over winter?
2. Is it transmitted through the seed?
3. Does the seed bed play any part in infection?
4. Is the disease transferred from plant to plant in the field, and, if so, by what means?

An attempt was made to obtain an answer to the first question by setting out clean tomato plants on the three fields found diseased in 1912. In one of these, the whole field of about one acre was replanted. In the second, 25 plants were grown in the space marked by six young trees, in which space the disease was known to occur in 1912; and in the third, 16 plants were also placed in a diseased square marked by young trees. In the last-mentioned case, additional evidence was furnished by volunteer plants, which came up here and there throughout the rest of the field. Not a single case of mosaic developed in any of these fields, either among the plants set out or among the volunteers. The evidence is, of course, too meagre to justify any general statement, but shows that under some circumstances at least, the disease is not transmitted in the soil. On the other hand, the observations from the 61 fields examined show that the disease is usually worst where tomatoes were grown the previous year.

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The second question, that of transmissibility through the seed, was also dealt with, and seeds collected from the worst diseased plants found in 1912 were grown again in 1913. In order to check the results, some were grown in four different places, viz.: Ontario Agricultural College, Guelph; Central Experimental Farm, Ottawa; Vineland Horticultural Experimental Station, and St. Catharines. None of the plants grown in the three first-mentioned places developed any trace of the disease. Of the 39 plants set out near St. Catharines, six developed the disease late in the season, and there is almost a certainty that the disease was not inherent in these, but was contracted from a diseased plant accidentally placed at the end of the row. The six affected plants were all at this end of the row, and, as previously mentioned, did not develop the disease till late in the season. The results of this work are not conclusive, but they indicate a strong probability that the disease is not transmitted through the seed.

There is good reason to suppose that the seed bed is the source of a good deal of infection. Mosaic plants are often found in rows in the field, half a dozen or more consecutive plants in the row being diseased while those adjacent in adjoining rows are clean. Since plants show the disease thus shortly after setting, before there is time for field infection to appear, it would seem that this peculiar occurrence of the diseased plants can best be explained by seed bed infection. In the ordinary method of putting out plants, those from the same part of the bed are likely to be planted consecutively along the row in many cases. I am assured by several growers of much experience that changing the seed bed often, reduces the disease or eliminates it altogether. Several cases have been met with where plants obtained from one seed bed show disease while adjacent parts of the field planted from another seed bed remain perfectly clean.

That the disease is transmissible from plant to plant, there is no doubt. Various investigators have shown that by injection of the juice of diseased plants into healthy ones, or even by rubbing the plants together, or touching one and then the other, the disease can be induced. Six plants injected with the juice of diseased leaves in this laboratory showed the disease in fourteen days. It is very probable that the disease is spread in the field either by insects, as in the case of tobacco, or by the brushing of the plants by the cultivator harness, etc. No satisfactory evidence has yet been secured on this point.

Spotted tomatoes.—Specimens of tomatoes affected by a superficial black spot (see Fig. 9, Plate 5) have been examined by the writer. The spots began as small circular white or yellowish areas under the skin, and, as the prick of a needle on green or half ripe fruit produces in a few days identically the same appearance, it is probable that insect punctures are responsible for the condition in the field. Later on the spot enlarges, becomes scabby and very black. A very few stray fungus filaments were found in some but not constantly enough to suggest fungus infection. Cultures made from the inner tissue of the spots remained sterile, and the spots on fruits kept in warm, moist conditions developed no further. No rot was caused in any case, the spot being purely superficial, so that the tomatoes were not injured for canning, although their appearance was spoiled for market purposes. That there are certain field conditions conducive to the trouble is evidenced by the absence of any blackening in numerous other cases, where similar white spots resulting from insect punctures have been met with elsewhere. Neither did the needle pricks, which produced the initial stages of the spotting in tomatoes grown on vines in the laboratory develop any blackening. It is suggested that the sulphur compounds in natural gas, which is abundant throughout the district where this spotting was found, may be responsible for the blackening of the spots.

Tomato black spot or black rot.—The causal fungus in this case (*Macrosporium solani*, E. & M.) is usually considered mainly as a leaf parasite by most authors. It is with us of little importance in this respect, and is found only occasionally on leaves

declining in vitality. On the fruit, however, it does occur as a rot fungus, in some cases so plentifully as to cause considerable loss (Fig. 2, Plate 4). It has been found by the writer most abundantly in weedy, and therefore humid situations, and was worst in the late fruit of early tomatoes. In order to determine that the rot was brought about solely by this fungus, cultures were made both from spores and from mycelium in the rot spots. Green and almost ripe fruits were then inoculated under proper antiseptic conditions, and with checks. In each of the ten inoculations made, rot spots were produced which gradually involved the whole fruit. The checks remained quite free (Fig. 3, Plate 4). It was evident from examination of the rotted fruits in the field that infection took place at insect punctures or other small wounds.

Dark green or blue green colour due to cold.—The cold, damp weather of the spring of 1913 caused a large number of the early set tomato plants to assume an unhealthy dark-green or bluish shade, and this condition was associated with very slow growth. Warm and sunshiny weather, however, soon restored them to a normal state of foliage, and no evil effects followed except the loss of a few days of early growth.

"Sooty fungus" on tomatoes.—Some young tomato plants were sent in, which were said to have a sooty fungus on the leaves. The leaves were covered with a black sprinkling much resembling the growth of a superficial fungus. Examination showed that this coating consisted of spores of Coprinus species, which had evidently grown in the hot bed and had shed their spores on the plants before transplanting.

5. GENERAL.

The preparation of nitro-culture.—During the last month of the year, it was deemed advisable for this division to prepare nitro-cultures of alfafa, red clover and peas for distribution to the branch Farms. This material is a pure culture of the organism found in the nodules on the roots of these plants. It has been shown without doubt that the function of these organisms is to fix the nitrogen of the air for the use of the plant. This constitutes the reason for these legumes being soil-improvers—through the agency of these bacteria they actually add nitrogen to the soil in which they are being grown. It very often happens that the soil in which the leguminous crop is sown does not contain this organism, so that no nitrogen fixation takes place. It is in these cases that the nitro-culture becomes of very great use; for the pure culture is mixed with the seed before planting, so that the bacteria can enter the young plant as the seed starts to germinate.

The system adopted for the isolation and multiplication of these legume bacteria was that of F. C. Harrison and B. Barlow given in the Trans. Roy. Soc. Can. Second Series, Vol. XII, Section 14, p. 157, and is as follows:—

The nodules are carefully washed in water to remove all adhering soil particles and then soaked for two minutes in a solution containing a small quantity of bichloride of mercury and hydrochloric acid, taken out and placed on filter paper slightly moistened with the same solution, to remove the excess of liquid on the nodules. They are then placed in sterilized water for a few minutes, one of them removed with sterilized forceps, and a longitudinal cut made in it with a sterilized, sharp, chisel-pointed needle. The point of a sterilized platinum needle is then inserted and moved around in the cut and dipped into a drop of sterilized water in a sterilized Petri dish, and into this is poured the medium in which these bacteria have been found to grow best, viz., a modified Ashby wood-ash agar. The cultures are then incubated at 20° C. In three to five days typical glistening and slightly opaque surface colonies will be seen, and transfers are made from these to a sloped tube culture.

OTTAWA.

To make sure that the organism isolated is really the one that inhabits the nodules of the plant under consideration, several tests have to be made, which are as follows:—

1. In culture, the organisms are very typically surrounded by mucilaginous sheaths; this can be demonstrated by air drying some of the material on a slide, flooding for an instant with water, and immediately flooding with gentian violet stain. This treatment causes the mucilage to contract and assume certain patterns or figures composed of bands and strands of fine or coarse intricately interlaced filaments, forming usually quite regular hexagonal figures.

2. Another distinguishing stain is the Kiskalt's Amyl-Gram. This is the same as Gram's stain, except that amyl alcohol is used instead of ethyl alcohol as a decolorizing agent. That is, some of the material is fixed on a slide, gentian violet added and warmed slightly over a flame for about half a minute, poured off and the slide flooded with a solution of iodine in potassium iodide for two to five minutes, and then discoloured with amyl alcohol. This stains the bacteria deep violet in a colourless background.

3. After the pure culture has passed these two tests, a final one is made by planting some seeds of the legume under consideration in six pots of sterilized soil with the seeds treated with the culture in three of them and untreated in the other three. When the plants are about three weeks old, they can be examined for nodules, and, if the plants from the untreated seed have no nodules and those from the treated seed have them, there is no doubt then that the culture is correct. It can then be transferred to media in bottles, and, when sufficient growth is made, it is ready to send out with instructions for its use.

RESIGNATIONS AND APPOINTMENTS.

Mr. J. W. Eastham, B.Sc., formerly chief assistant botanist, resigned his position in April, 1914, to take up a position as plant pathologist under the British Columbia government. In Mr. Eastham, the division has lost the services of a very able and painstaking official, who has rendered very satisfactory service during his tenure of office.

Mr. John Adams, M.A., formerly of the Royal College of Science, Ireland, was appointed to a position under the Destructive Insect and Pest Act in May, 1914, and later received the appointment of Assistant Dominion Botanist. The appointment of an officer possessing, as Mr. Adams does, such excellent qualifications, is most gratifying, and all the more so because of his training and previous experience.

Mr. F. Lisle Drayton, B.S.A., a graduate of Macdonald College, Quebec, was appointed Assistant Plant Pathologist and Bacteriologist in July, 1914. Mr. Drayton's work is mainly of a research and advisory nature, and the services which he has already been able to render have been throughout most satisfactory.

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OFFICIAL PUBLICATIONS OF THE DIVISION DURING THE YEAR OF REPORT.

Exhibition circulars:—
- 44. Potato Scab, by J. Adams.
- 45. Do you know your weeds? by Faith Fyles.
- 46. Apple Scab, by F. L. Drayton.

Farmers Circulars:—
- No. 6: Regulations under the Destructive Insect and Pest Act governing the importation, sale, shipment and exportation of the Common or Irish Potato (*Solanum tuberosum* L.), by H. T. Güssow.
- No. 9. The control of Potato Diseases, by H. T. Güssow.

Bulletins:—
- No. 23: Second Series—Medicinal Plants and their Cultivation in Canada, by John Adams.
- No. 24: Second Series—Fruit Tree Diseases of Southern Ontario, by W. A. McCubbin.

ACKNOWLEDGMENTS.

The success of the work rests largely with the members of my staff, who are in charge of special subjects. I desire here to record to all, my great indebtedness for their uniformly interested and satisfactory services rendered during the year.

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DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

REPORT

FROM THE

DIVISION OF BOTANY

FOR THE

Fiscal Year Ending March 31, 1916

PREPARED BY

THE DOMINION BOTANIST

OTTAWA
PRINTED BY J. DE L. TACHÉ, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1917

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REPORT OF DIVISION OF BOTANY

H. T. GÜSSOW, DOMINION BOTANIST.

OTTAWA, March 31, 1916.

The Director,
Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to submit herewith the seventh annual report of the work carried on by the staff of the Division of Botany.

The report gives detailed accounts only of such work as is held to be of most general interest to the public. Occasional inquiries, because of their more individual or local interest, are not mentioned, although they were numerous enough to occupy considerable thought and attention.

In the preparation of this report the Dominion Botanist was greatly assisted by the members of his staff, and credit is given to the services rendered by the individual members in the preparation of their respective contributions. I desire here to record my great appreciation of the faithful and invaluable services rendered by each of my colleagues. Without their co-operation much of the work accomplished during the year would have been very inconclusive.

As usual, the report is divided into several sections, viz.: I, Destructive Insect and Pest Act; II, Plant Pathology; III, Economic Botany; IV, Report from Field Laboratory at St. Catharines; V, Report from Field Laboratory at Charlottetown, P.E.I.; VI, Report from Field Laboratory at Fredericton, N.B.; VII, General.

I have the honour to be, sir,
Your obedient servant,

H. T. GÜSSOW,
Dominion Botanist.

I. DESTRUCTIVE INSECT AND PEST ACT ADMINISTRATION (PLANT DISEASE SECTION).

Potato Inspection.—The potato inspection inaugurated in New Brunswick in the fall of the previous year was continued until October 7, 1915. Shipments to Ontario and the western provinces were particularly heavy during the months of April and

ments of the crop of 1914 and the first inspection of shipments of the 1915 crop. From July 12, the seven inspectors still remaining in the province were employed for several weeks in experimental work and field inspection of potatoes; two of them also attended several of the Provincial Agricultural Exhibitions with exhibits of plant diseases, and were able to give a good deal of information of an educative nature to those with problems along this line.

On August 27 the first inspection was made of shipments of the new crop, and from that date until October 7 a busy time was experienced in dealing with all the calls for inspection, chiefly due to the loading points being widely separated and the reduced inspection staff. However, by increased efforts on the part ot every member of the staff, it was possible to cope with the situation.

This work was under the supervision of Mr. R. Holmden until July 8, when he was transferred to Prince Edward Island. On October 7 the regulations were cancelled.

The following figures show the number of cars and bushels inspected between April 1 and October 7, 1915:—

	Cars.	Bushels.
1914 crop "first grade" to Ontario	36	25,413
1914 " " Manitoba, Saskatchewan and Alberta	129	90,687
1914 " "table" Ontario	693	465,662
1915 " " "	394	231,714
Total	1,252	813,476

On October 8 the inspectors were sent out to revisit the farms where field inspection had been carried on, for the purpose of inspecting the crops at harvest time. This work took considerable time as the farms were scattered over a great part of the province; where it was not possible for an inspector to be present at the harvest time, a thorough examination of the crops was made afterwards in the cellars. A part of this work was undertaken for the Canadian Seed Growers' Association.

During the late fall and winter, a number of farms have been visited for the purpose of ascertaining the quality and general condition of the crops in the cellars, and for giving information regarding any diseases present. In this connection, some 340 farms were visited, records being taken in each instance of the conditions found.

White pine blister rust in Canada.—Attention must be called to the outbreak of White Pine Blister Rust, which was unknown on the continent of America until recently. The disease has been most destructive in European countries, and every effort is necessary and is being made as far as possible to prevent this disease from establishing an alarming situation in Canada. I am indebted to Mr. Clyde Leavitt, Forester, of the Commission of Conservation for a memorandum of the commercial importance of the white pine in Canada, from which it may be gathered that any disease likely to prove destructive to this important forest tree must be considered from the aspect of the economic conditions and natural resources of the country:—

Prof. Wm. Sommerville, D. Oec., a British authority, writing on conditions of this rust in Great Britain, states: " This disease is so much on the increase that it is not too much to say that the outlook in this country for the white pine is almost hopeless. If it spreads in North America, as it has done in Europe, the loss that will result through the destruction of one of America's most valuable lumber trees can only be described as appalling."

The Forestry Branch of the province of Quebec must be congratulated on having vigorously taken up the work of control, and on producing a most instructive circular containing a coloured plate of this disease, which we understand is widely distributed throughout Ontario. The attention of all lumbermen, foresters, and others interested in the preservation of this valuable forest tree is directed to this danger. It is hoped that one and all will co-operate in the effort made to defeat one of Canada's most important foes to her white pine resources.

Mr. W. A. McCubbin, M.A., assistant in charge of the field laboratory at St. Catharines, is in a position, from the work done under his direction, to report on the present status of White Pine Blister Rust in Ontario, and his account, together with a number of instructive photographs, will be found of interest:—

"Among the latest nuisances that have been imported here from other lands is one that hails from Europe, where it has been a well-known pest for many years. It is the White Pine Blister Rust, *Peridermium Strobi* Kleb. As the common name indicates, it is chiefly noted as a fungus parasite of the White Pine, *Pinus Strobus* L., but it can also attack several other species of pines, viz.: *P. cembra, P. monticola, P. excelsa,* and *P. Lambertiana,* and perhaps any or all of the other thirteen species of five-leaved pines. It may be noted in passing that the five-leaved pines alone are susceptible, and that the two- or three-leaved species, including the Austrian pine, the Scotch pine, and the jack pine of our northern forests are not subject to the disease.

" The most serious phase of the blister rust on the white pine occurs in the seedling stage. It is believed that the fungus gains entry by some wound in the twig or branches and from there it grows up and down and around the branch in the soft bark. In a short time the limb or stem is girdled, and the part above the affected area dies. The presence of the fungus in the tissues causes a considerable swelling of the limb, and this swelling often takes on a sickly, yellowish appearance. Once established, the fungus progresses down the branch or stem year by year. Each spring there arise, from the swollen discoloured tissue invaded during the previous year, numerous pale orange or whitish blisters, filled with countless spores. It may take branch infec-

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spores that where black currant plantations are numerous in a district all the fields for several miles around may be rusted before the end of the summer. Although the spores produced in the early part of the summer on currant leaves are incapable of infecting pines, yet towards the close of the season the pustules put out small peg-like growths on which spores are formed which are able to infect pines again; and since, as noted above, the rust may spread on currants for several miles, there is every danger that a new lot of pines may be infected a long distance away from the original pine from which the currants received their infection in the spring.

"This stage of the rust on the currant has usually been considered of minor importance as a currant disease. Perhaps where currants are few and distant from each other little damage may be caused; but in the Niagara district where there are numerous large currant plantations close to each other, the disease has been so plentiful in the last two years that it promises to become a serious pest. In many cases the black currants were completely defoliated long before the end of the summer, and in the warm weather of early fall the winter buds on these canes started into growth. The second set of leaves thus produced, (Plate LV*b*), were usually rusted in their turn, and all of course perish in the first autumn frosts. Since this secondary foliage destroys the winter buds and uses up a considerable amount of the food stored for spring growth, the effect on the general vigour of the plant is disastrous.

"So far as we yet know, the rust on the currants dies out in winter and infection has to start again each spring from some blister canker on a nearby pine.

"We have here then a disease, the life-history of which may be summed up as follows—

"(A). On the Pine.—

"1. Attacks only five-needled pines, on which it lives perennially in the bark of the limbs and stem.

"2. It produces cankered areas with discoloured swellings. (Plate LIII*a* and *b*.)

"3. Limbs or stems are girdled and killed; seedlings are killed rapidly, adult trees more slowly.

"4. Spores produced in early spring from canker blisters may infect nearby currants, but not pines again. (Plate LIII*c*.)

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"(B). On currants.—

"1. On all wild and cultivated currants and gooseberries; black currants particularly susceptible.
"2. Leaves only affected; small orange-coloured pustules on the under sides. (Plate LIV.)
"3. Spores from these pustules spread the rust in summer to other currants, but not to pines.
"4. In fall or late summer spores capable of infecting pines are formed.
"5. The rust probably dies out each winter on the currants, and has to be started in the spring from pines again.

"It is well established that the Blister Rust was brought to this continent from Germany, Holland, and France, on white pine seedlings imported for nursery purposes. Both in the United States and Canada numerous infections in different districts have been definitely traced to some seedling pines affected by the disease, and either standing in the nursery row or planted out in shrubberies or forestry plots. In only one case in Ontario has the disease been found on native white pines, and as these trees were standing close to two nurseries, it can hardly be doubted that imported nursery trees were the original source of the disease.

"The work carried out by this laboratory during the past year included such surveys and experiments as would help to establish a basis for the extensive control measures which it was felt would surely be necessary in the future.

"An attempt was made to locate the actual areas in Ontario already occupied by the disease. This work was carried out in conjunction with Prof. J E. Howitt, of the Ontario Agricultural College, and in the accompanying map all the infections known to be present in 1915 are recorded.

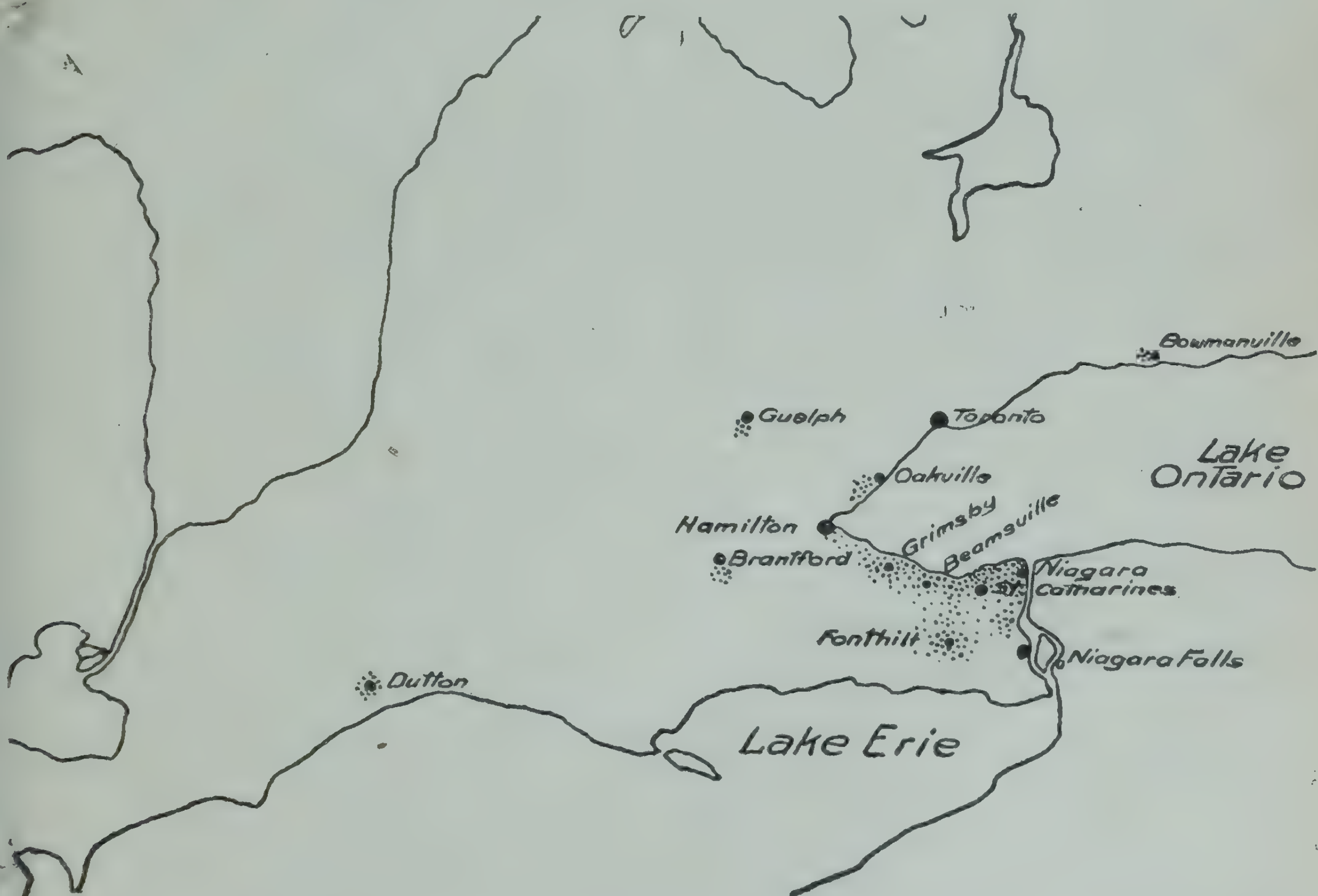

Fig. 1. Map showing the distribution of the Currant Rust in Ontario in 1915.

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"In addition, special attention was given to the main outbreak in the Niagara peninsula, and efforts were made to locate as many sources of infection as possible, by inspections of nursery pines, pine plantations, and woodlots. Eight nurseries were thus inspected. Of these only three contained five-leaved pines, and in only one of these was the *Peridermium* found. It was present here on three imported seedlings. Seven lots of imported pines which had been planted out in various places as ornamental trees were all found to be free from the disease. Over 900 native pines in eleven different woodlots were also examined as carefully as possible. In this case no effort was made to inspect trees older than 12 or 15 years of age, since it was found impossible to locate the disease in the taller trees with any certainty. In the eleven woodlots mentioned only one showed any sign of the disease, and here there occurred over 200 cases of the Blister Rust, on branches and on the stems of young trees. These were not all found at one time, but were located in the several visits made during the summer. As soon as they were found they were cut out or the tree destroyed, but in succeeding visits more cases could always be located. The difficulty that was here met with in locating all the infected limbs indicates that any inspection work of this nature will have to be conducted with extreme care in order to be successful.

"From this woodlot as well as from the affected nursery mentioned, both of which were at Fonthill, the disease was seen to have started on nearby black currants on June 3, and from this centre the currant rust spread in an ever widening circle all through the summer. Outside of this well defined area of infection no rust appeared in the rest of the peninsula east of Beamsville until long after this date. In the region lying below the escarpment between Beamsville and Niagara-on-the-Lake, surveys made up to July 6 disclosed no sign of rust on currants. At this date the Fonthill epidemic had spread approximately two miles from the original source, and the hope began to arise that the Fonthill pines were perhaps the only source of the disease in the whole of this end of the peninsula. On August 9, however, in another survey of the district between St. Catharines and Niagara-on-the-Lake, rust was found on every field between these points, and a similar survey to the west of St. Catharines, made on August 10, showed that the currants were rusted to a slight extent in that direction for some five miles, though the Jordan, Vineland, and Beamsville districts were free. Since, at this time, the infected area at Fonthill was separated from this lake district by a zone of disease-free currants several miles in width, it seems natural to conclude that one or more sources of infection were present in the lake shore region, though no affected pines could be located there.

"From this time on the rust advanced into fresh territory, until at the end of the summer it had reached Beamsville, where it joined with a similar large area of infection, the source of which was apparently at Grimsby. A similar spread took place in the Fonthill area, which by fall had occupied the large territory shown in the map.

"During the progress of this survey work an effort was made to find out how far the spores of the rust may pass from one currant field to another, a very important point in connection with the spread of the disease. In some of the outlying townships where the currant fields are few and there is little or no bush where wild currants or pines might be a possible source of infection, it was established that leaps from field to field of at least half a mile may occur. In this connection it may be noted that, according to the observed rate of spread of the disease in an infected area, and allowing for a two-weeks' incubation period, the actual distance to which the spores may be transported would be much greater than this, as much as two miles perhaps.

"Another point of importance in the disease is the question of how long the æcidiospores from the pine blisters will retain their power to infect the currant. In order to obtain some answer to this question, a young pine tree with the blister stage well developed was brought in from the affected wood lot on May 6, and kept in a box where it was allowed to dry out. Infections on currant leaves were made from the spores from the blisters on May 7, May 21, June 4 and June 23. In each case the spores

were mixed with water and applied to the under sides of the leaves with a camel's hair brush. The leaves were then enclosed in bottles to keep them moist. Only the first three infections were effective. The last series on June 23 produced no rust, although the precaution had been taken of infecting leaves of three ages. On the successfully infected leaves the rust pustules appeared after ten to twelve days, and in twelve to fifteen days spores were produced.

"While these experiments were too few in number to establish the life-limit of the spores with accuracy, yet they indicate clearly that spores from the pine blisters will retain their infective power for a month at least. It also appears that the period of incubation, or the length of time from infection until spores are formed again, is about two weeks. This result closely agrees with the records of other experiments on the same point.

"A very important phase of the Blister Rust question is whether the fungus will winter over on the currant, or whether each year's currant infection has to be started from some infected pine in the spring. Attempts have already been made to settle this point, and the results seem to indicate that no wintering on the currant takes place. It was thought advisable, however, to make some further trials along this line with reference to our own conditions. Accordingly, there were secured from a local nursery 100 two-year-old black currant plants (Boskop Giant), from a stock that had been very badly rusted in 1914, and these were planted out in five lots in a region that was known from personal observation to have been free from rust the preceding season. These plants were taken up from the nursery rows on April 18 and shipped to the northern end of Peel county, where they were planted out about April 20. Although this district was primarily chosen because of its freedom from rust, it was also suitable for the purpose on account of the scarcity of pines in the neighbourhood, as well as for the fewness of its currants; so that should any rust develop on the experimental plots, the danger of starting an epidemic would be reduced to a minimum. In each case the owner was given a specimen of the rusted currant leaves mounted under glass, for comparison, and requested to keep a careful watch for any sign of the disease.

"The treatment accorded to each of the lots was as follows:—

Lot 1.—Twenty-five plants; fumigated but unsprayed.
Lot 2.—Twenty-five plants; fumigated but unsprayed.
Lot 3.—Twenty plants; fumigated and sprayed with soluble sulphur before removal from the nursery rows.
Lot 4. Twenty plants; fumigated and sprayed as in lot 3.
Lot 5.—Ten plants; fumigated, and sprayed as in lot 3; in addition badly rusted currant leaves which had been kept out of doors in a basket over winter, were suspended in wire cages amongst the foliage of these plants, in order to give an opportunity for infection from this source.

"Besides relying on the watchfulness of the owners to determine the first occurrence of any rust spots on the leaves, a thorough examination was made of all of them on May 24, at which time no sign of the rust could be seen. It was thought that any infection from over-wintered spores would be quite evident at this time, so no further examinations were made during the summer except in the case of lot 5, which was inspected again on August 27, and found to be still free from rust.

"A final round of inspection on October 18 showed that all these plants were still entirely free from rust infections, with one exception: a few leaves on one plant in lot 3 were found to be affected by the disease.

"At first sight it would appear that there is here authentic proof that the rust is self-infecting on the currant, *i.e.*, that it will perpetuate itself from year to year without having to be started each spring from an affected pine. This point is of such extreme importance from the practical side, however, and the proof rests so entirely

on one single case obtained from a rather restricted set of experiments, that it would be unfair to draw the above conclusion without a careful study of all the circumstances.

"When found on October 18, the infection was still very restricted, involving only one plant—perhaps a dozen leaves. It was plainly of the two-cycle type, *i.e.*, there was a small original rust spot, now of considerable age, and a number of recent pustules, all of equal age and which had evidently been started by spores from the older spot. The leaf on which the original spot occurred was two-thirds of the way up a shoot of the present year's growth. All the other pustules were on leaves adjacent to this one. All the spots were at this time producing the teleuto-stage, and the parent spot showed in its tendrils the whitish furry coat characteristic of the presence of sporidia, but the secondary spots had not yet reached this stage.

"There are, I take it, three ways in which infection could have taken place in this case:—

1. Locally, from some nearby pine or currant.
2. Self-infection, either by means of adherent spores, or from hibernating mycelium.
3. Accidental infection of some kind.

"Concerning the possibility of infection from any local source, the writer is perfectly convinced that it could not have taken place. All of the very few currants within the radius of a mile have been carefully examined and no trace of the rust found. There are several old native white pines in a lane a little less than half a mile away, and no others within a radius of a mile and a half. The region is very hilly, wooded and sparsely settled, and so little attention is paid to the growing of small fruits that few if any nursery currants have been planted in the neighbourhood in recent years.

"The possibilities are, therefore, reduced to either self-infection or to accidental infection of some sort. With regard to the latter, the various chances by which spores could have been transferred from the nearest affected area, 60 miles away, were considered. The remote chances of infection being brought in basketed fruit, nursery stock, or in the clothing of visitors from a rusted district, could all be readily disposed of by the testimony of the owner. There are practically two other possibilities left; migrations of birds, and the inspection visit of May 24. Although no currant pustules had been met with before that date, some inoculations had been made in the laboratory from pine blisters on May 21, three days before, and it is conceivable that some of the spores had been carried in the clothing of the writer to this field at the time of inspection.

"Vague as these possibilities may be, yet they cast such doubt on the otherwise clear case of over-wintering that there can remain but a suspicion that the fungus may live on the currant itself and start a new infection during the second season.

"The method of fighting the disease which has been used heretofore consists of a careful survey to locate the infected pine or pines, and the immediate destruction of these when found. In isolated areas where either pines or currants are few, this method can be relied upon to give satisfactory results, especially where it can be continued year after year without much danger of the spread of the disease because of the scarcity of either host. Judging from the experience of the United States Forest Service in stamping out a number of infected areas in that country, we may not find exceptional difficulty in eradicating the Blister Rust from the isolated districts in the province. But in the case of the main region affected, which contains over 300 square miles of territory, the problem promises to be extremely hard to solve. Not only are there thousands of currant plantations, large and small, throughout the Niagara Peninsula, thus permitting the rust when once started to sweep over miles of country, but there are as well immense numbers of half-grown and seedling pines scattered about

the whole section, all exposed during the summer to wholesale infection. It would be almost miraculous if there are not now established thousands of pine infections, each capable of starting an epidemic of currant rust.

"Any adequate inspection of the pines in this district would be a stupendous task, and even with the utmost care in this work the location of more than 90 per cent of the blister cankers would be a virtual impossibility. If currants were scarce and far from each other perhaps the disease would be reduced in successive years and finally eliminated, but the presence of so many currants in close proximity makes it possible for the 10 per cent of cankers remaining to start practically as much rust as if the whole lot were left, and in this way the pine infections will each year be plentifully renewed.

"Spraying currants has suggested itself as a means of dealing with the disease. This phase of the subject has been given some attention during the recent summer. Two black currant plantations in the affected district have been sprayed at intervals of two weeks throughout the summer, one with Bordeaux mixture and one with soluble sulphur. It was realized that the spray would have to be applied to the under sides of the leaves to be effective, and though this was done as thoroughly as possible in our work, it must be admitted that it takes so much time and care that satisfactory spraying of this kind would be out of the question in a commercial way. Owing to frequent rains during the summer the best results were not obtained from this work, but even allowing for this it was certain that, though the amount of the rust can be greatly reduced by spraying, it cannot be controlled sufficiently to prevent the spread of infection. (Plate LV*c*.) Consequently, whatever value spraying methods may have as a means of protecting individual plantations, they are likely to be of little use in combatting the disease as a national pest. In this connection it has been suggested by the Dominion Botanist that since spraying will not completely control the rust, it may work a positive harm by keeping the infected leaves longer on the bushes in the fall, and thus materially extending the period during which infection of the pine may take place, providing, of course, that the infection of pines is possible throughout the whole season.

"There is still another cause for alarm in the present situation. Millions of fruit packages are sent out from the Niagara fruit district each year, and great numbers of these undoubtedly carry with them to other parts of the province the spores of the rust. It can not yet be definitely stated how long these spores retain their power of infection, but if it is even so short as a few days, there is a constant danger of the disease being spread into other parts of the province by this means. For this reason a yearly inspection of the whole province will probably be found necessary until danger from this source has been eliminated.

"On account of the stringent regulations in force regarding the importation of European-grown pines, there is little likelihood of further introductions of the disease, so that, if it can be eradicated from the areas now infested, our white pine forests, which are still of untold value to the nation, may yet be saved from its ravages."

II. PLANT PATHOLOGY.

From the records of the weather it would appear that the belief that rainy seasons are responsible for much damage to crops from diseases, was fully confirmed.

It was a most unusually favourable season for "Late Blight" in potatoes and the damage done was considerable and universal in the eastern parts of the country. In regions where Late Blight does not usually cause heavy losses, they were considerable; and in certain localities where potato spraying is still regarded with indifference, or where the belief exists that no profits are to be made from spraying, the losses amounted to almost 50 per cent of the possible crop.

If the spraying of potatoes is really a protection for the potato crop, it would be best demonstrated during seasons like the one just past where the disease was widely

prevalent. The field stations situated at Charlottetown and Fredericton, therefore, undertook spraying experiments on a number of privately owned farms, with the result that an acre of sprayed potatoes yielded on the average in New Brunswick and Prince Edward Island some 100 bushels more than an acre of unsprayed potatoes.

To give one striking example of the ravages of Late Blight will suffice, though many more may be quoted. An inspection was made by the Dominion Botanist and others interested, of a potato field just when the potatoes were being harvested. The disease had gone into the tubers, and 28 per cent of the total tubers harvested were useless for anything but immediate stock food. This farmer would have scarcely succeeded in keeping any quantity of this crop over winter, as storage rots would have surely destroyed many bushels, if not all. It is most unfortunate that all farmers do not provide for suitable storage. The conditions prevailing in most cellars are very unsatisfactory; they are too warm and too moist, with almost no ventilation. Potatoes require a cool storage place, where the temperature does not rise above 38° F. at the most. Naturally, the cellar must be frost-proof.

In Ontario, in the early part of the season, there was quite a promising crop, but owing to the wet weather this promise was not fulfilled. The heavy rainfall retarded growth and caused a wet rot of the stalks, and many plants died. Many fields could be observed with water standing between the rows and the tubers rotting in the ground (Plate LVI).

New Ontario promises an excellent region for potatoes. As an example may be cited a field near Earlton, where a single hill selected at random produced twenty-nine tubers of table size.

Ontario is fortunate in being reasonably free from serious potato diseases. Common Scab is the worst trouble, but there are few diseases of general importance. Leaf Roll, Curly Dwarf, Mosaic, are exceedingly scarce, and it is hoped that the Ontario farmers will exercise great care in keeping their crops free from diseases. It would be well to adopt the methods outlined in the Division's Circular No. 9, entitled "the Control of Potato Diseases."

Powdery Scab Experiments during 1915.—The experiments were placed in charge of Mr. F. L. Drayton, Assistant Plant Pathologist, under my direction. Mr. Drayton deserves much credit for his attention to this phase of work.

At the request of the Dominion Botanist, Mr. P. A. Murphy, Assistant in charge of the Prince Edward Island laboratory, critically collated the results obtained.

The following experiment on the treatment of "seed" potatoes for the prevention of Powdery Scab was carried out at the Central Experimental Farm, Ottawa, and at the Experimental Stations at Charlottetown, P.E.I., Fredericton, N.B., Kentville, N.S., and Ste. Anne de la Pocatière, Que. The experiment was on the same scale (except at Ottawa), and similarly conducted, at all places. The "seed" used was naturally infected and as nearly uniform as could be procured, but it was not all of the same variety at the same Station. One of the difficulties of this experiment is to obtain sufficient "seed" of one variety which is all equally infected. The soil was in all cases virgin.

Each plot consisted of a single row thirty inches wide planted with sixty sets (except in the case of Ottawa where the number varied from sixty four to one hundred and ninety-two), placed twenty inches apart. The sets consisted of whole tubers. There were nine plots, the "seed" for each being treated differently, as follows:

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TABLE I.—Showing the treatment given the "seed" for the different plots.

Plot.	Substance or treament used.	Strength or manner of use.	Length of treatment.
1	Corrosive sublimate	1:1000	1½ hours.
2	" "	1:2000	3 "
3	" "	1:3200	Over night.
4	Formalin	1:300	3 hours.
5	"	1:600	3 "
6	Flowers of sulphur	Damp tubers rolled in it.	
7	Copper sulphate	1:170	3 "
8	Tubers kept in warm room before planting		22 days.
9	No treatment. Check		

The percentage of tubers by number affected with Powdery Scab at each of the five places where the experiment was carried out is shown in the next table.

TABLE II.—Showing the percentage of tubers by number affected with Powdery Scab in the different experiments.

Plot.	Percentage of tubers by number affected with Powdery Scab.					
	Ottawa.	Charlottetown.	Fredericton.	Kentville.	Ste. Anne de la Pocatière.	Average of all experiments.
1	0·0	0·0	2·1	5·9	7·0	3·0
2	0·0	0·0	1·4	11·0	8·1	4·1
3	0·0	0·0	2·7	6·4	10·6	3·9
4	0·0	2·1	2·7	11·2	11·3	5·5
5	0·0	2·3	1·0	6·7	13·2	4·6
6	1·8	2·5	1·9	8·3	17·9	6·5
7	0·6	2·3	1·8	9·7	6·7	4·2
8	37·9	4·5	9·6	53·5	66·0	34·3
9	8·3	1·6	10·2	12·9	41·2	14·8

If we examine the average of all the experiments, first, the outstanding fact is, that keeping the seed potatoes in a warm room for twenty-two days more than doubled the amount of scab, increasing it from 14·8 per cent to 34·3 per cent. This result was constant at all Stations except Fredericton.

Of the disinfectants, corrosive sublimate proved itself the best, closely followed by formalin. While corrosive sublimate in the three strengths used was entirely effective in preventing the disease at Ottawa and Charlottetown it was not so at the other three Stations. There is little to choose between the three strengths, although the concentration of 1:1000 is slightly the best. The results on plot three, in which the seed was treated with corrosive sublimate 1 part to 3,200 parts of water over night, prove that this disinfectant is effective in much lower concentrations than that in which it is usually employed. Experiments previously carried out by the Division of Botany have shown that it is quite as effective in the proportion of 1 to 2,000 parts of water as in the strength of 1 to 1,000 if the time of application be increased to three hours, and these results are substantially borne out here.

At one Farm only, Ottawa, did formalin prove entirely effective, while at the others it reduced the amount of disease on the average from 14·8 per cent to 5·5 per cent in

the case of formalin of strength 1:300, and to 4·6 per cent when the 1:600 strength was used. In two of the experiments the former gave better results, and in two the latter, so that it is likely that the difference does not exceed the experimental error; in which case it may be assumed, provisionally at least, that concentrations greater than 1:600 will not be justified by the results.

Flowers of sulphur and copper sulphate were the other disinfectants tried. The former had a tendency to interfere with the sprouting of the sets and to cause misses, while at the same time it proved the least effective germicide. The effect of the copper sulphate treatment in causing misses was much more marked and the hills which were produced had an average of 2·4 tubers less in them than the average of the other rows. As a preventive of Powdery Scab, copper sulphate ranks somewhat better than formalin and not so good as corrosive sublimate, but its deleterious action on the sets renders its use as a potato disinfectant impracticable.

Turning to plot eight, the seed for which was kept in a warm room for twenty-two days before planting, we are confronted with the fact already mentioned, that this method of storing more than doubled the amount of disease on the average, the increase being very marked at every Station except Fredericton, where it was slightly less than on the check plot. It is not easy to offer an explanation of this phenomenon without further experiments. A tentative reason may, however, be put forward, namely, that the temperature was a favourable one for spore germination, thus increasing the amount of actual infecting material as well as the time in which it had to act. In the other plots it would take some time after planting for the spores to germinate, and it is possible that fewer of them would do so than if they had been previously stimulated thereto by being kept some time at a warm temperature. It may also be that the tuber must be attacked at a particular stage of its development, possibly an early one, which would help to bear out the above hypothesis. This, also, would prove one of the two most obvious explanations of the recently reported failure of Kunkel[1] to infect potato tubers with cultures of (presumably) *Spongospora subterranea.* The supposition is easily credible when we consider that in most cases an affected tuber is able to isolate the invader in a small area, the scab spot, by means of a ring of cork, indicating that the parasite is, as a rule, unable to penetrate such tissue. This may also hold in the case of roots, which, at least in the Charlottetown experiment, were attacked by the fungus. as Pethybridge[2] described some years ago in Ireland, with the production of galls. Melhus and Rosenbaum[3], in making the first recorded discovery of this in America, were apparently ignorant of the fact that it had been known in Europe for several years.

The theory is also strengthened by previous experiments carried out by the Division of Botany. It has been found to be very difficult to transmit the disease to new tubers on clean soil through the agency of infected tubers kept over winter in a living room. A likely explanation of this is that the spores germinated, and, not finding a favourable medium for their development, apparently, died, or were at all events unable to cause infection in the spring. The *amoeba* (accepting the most recent work of Kunkel[4] on this point) produced on the germination of a spore may under such circumstances encyst and so tide over for some time at least an unfavourable period, but that it can do so an indefinite number of times, as Kunkel[5] holds, and still retain its vitality is open to serious doubt. In this, as in several other questions, there is urgent need for someone to clear up the discrepancies which exist in the accounts

[1] A contribution to the life history of *Spongospora subterranea.* Jour. Agr. Research, 4, 1915, pp. 265-278.

[2] Investigations on Potato Diseases. Jour. Department of Agriculture and Technical Instr. of Ireland.

[3] *Spongospora* on the roots of the potato and on seven other new hosts. Phytopath, 6 1916, p. 108.

[4] l. c.

[5] l. c., p. 275.

given by Johnson,[1] Massee,[2] Horne,[3] Osborne[4] and Kunkel.[5] This view seems to be at variance in another way also with the results of the last-named author who would probably hold that a potato in storage is a favourable medium for the parasite to thrive on since he finds that it feeds on the cells surrounding the scab spot. On the other hand, the views are in some agreement because Kunkel finds that the spore may germinate to some extent in storage, a process which could, presumably, be hastened by more favourable temperatures, as the present author suggests.

It will be noticed that there is extreme divergence at the different stations in the amounts of disease which occurred. This cannot be explained by the "seed" which was as uniform as could be procured; nor can it be a climatic factor because the amount of the disease present in a province and that showing in the experiment conducted in that province are by no means in direct proportion. There are no grounds whatever for believing that the ground was infected in any case. At Ottawa and Charlottetown, where the disease was least, the potatoes were grown on wet, low-lying soil, one being clay and the other "muck" or peat. A good many of the sets missed for this reason, particularly at Ottawa. In the Charlottetown experiment, it was particularly noticeable that twenty-nine of the thirty-one plants which produced diseased tubers were at the extreme upper and drier ends of the rows. The physical condition of the soil during the growing season appears to have been more nearly normal at the other Stations. From this it seems to follow that wet soil and a low percentage of disease are associated, a result which is in direct opposition to the generally accepted view that the parasite is more harmful on wet than on dry land, which view is, however, based on no experimental evidence. It is intended to inquire into the matter further.

It was the experience in practically all the experiments that the plants in row eight (the "seed" for which was kept in a warm room for twenty-two days before planting) developed more quickly than the others. This might be explained by the sprouting of the tubers while they were in the warm room. However, the maturing was not only early but premature. The plants did not reach full size and the same was found to be true of the tubers when they were dug. It was further found that while the size of the tubers had decreased the number had increased, in fact in all the plots the number of tubers was about in proportion to the virulence of the disease with the exception of those in which sets treated with flower of sulphur and copper sulphate had been planted. In these the injurious action of the chemicals on the sets introduced a second variable factor. So far as the author is aware there is no previous record of Powdery Scab as exerting an influence on the plant in reducing its vigour and yield, nor of increasing the number of tubers at the expense of their size. The following table shows the average number of tubers per hill together with the average number of diseased tubers in the five experiments.

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1 Some injurious fungi found in Ireland. Econ. Proc. R. Dublin Soc., I, 1907, pp. 345-370. *Spongospora Solani* Brunch. (Corky Scab.) Ibid. I, 1908, pp. 453-464.
2 Diseases of cultivated plants and trees. London, 1910.
3 A preliminary note on *Spongospora Solani* Brunch, Ann. Bot. 25, 1911, p. 272.
4 *Spongospora subterranea* (Wallr.) Johnson. Ann. Bot., 25, 1911, pp. 327-341.
5 l. c.

TABLE III.—Showing the direct relationship which exists between the amount of disease and the number of tubers developed in a hill.

Plot.	Treatment.	Percentage of tubers affected with Powdery Scab.	Number of tubers per hill.
1	Corrosive sublimate 1:1000	3·0	7·2
2	" " 1:2000	4·1	7·8
3	" " 1:3200	3·9	8·5
4	Formalin 1:300	5·5	8·8
5	" 1:600	4·6	8·8
6	Flowers of sulphur	6·5	9·4
7	Copper sulphate 1:170	4·2	6·2
8	"Seed" kept in warm room	34·3	9·7
9	Untreated	14·8	8·9

Further experiments of a preliminary nature were conducted on a small scale at Ottawa. They were designed to show in part, the effect on the disease of the hot water treatment as it is used for the loose smuts of cereals, and in part to throw more light on the effect of keeping "seed" tubers at various temperatures for different lengths of time. In the former particular the results are gratifying, but a considerable amount of further work will have to be done before any general conclusions can be drawn.

Improvement of the potato crop.—From time to time the Division receives applications from persons who, having heard of the use of evaporated potatoes, have become interested in the subject. They have evidently seen references in literature to a system largely practised in Germany which, it may be said, yields an important revenue in that country. In this country the installation of potato drying or evaporating plants, and the financial success to be expected from such work, would be very precarious under the present uncertain condition of the potato crop in the Dominion. The reason for such an expectation will be apparent to any business man, when it is pointed out that during the season 1914-15, the average price of potatoes was about 40 cents per barrel of table potatoes, whereas during 1915-16 the price was three times that, and more. Moreover, one year one part of the country may have a superabundant crop, but it generally finds a ready market in parts of Canada where the crop happens to be deficient. Thus, during 1914-15, Eastern Canada shipped large quantities to the West as far as Alberta, but during 1915-16 Alberta potatoes were largely in demand in the East. As long as farmers and shippers are able to dispose of their potatoes for table or seed purposes it will be waste of capital to evaporate potatoes. The reason for this is simple: Canada cannot yet rely every year upon a uniformly satisfactory crop of potatoes. Shipping and marketing facilities are not yet sufficient for the disposal of the crop, though large in certain localities, at a profit. Some years ago we were shown a large dump pile of potatoes that were grown and harvested on a farm in British Columbia. When they might have been shipped, it was found that it would not pay to ship them at the price that could be obtained for them. This might be used as an argument for the establishment of, at any rate, local evaporation plants. But that very same farmer probably had to buy his potatoes for his own use the following year. Would any manufacturing firm be able to afford idleness one year? Germany is using for evaporation only those potatoes left over after all her other requirements for domestic purposes, seed and other uses, have been fully guaranteed. Do we suffer yet in this country from over production—so much so, that we must look for some use for our surplus potatoes? The fact is, that we produce hardly enough potatoes, taking one year with another. Otherwise, the fluctuations in the price of this commodity would not occur or at any rate would not vary within such wide limits. The most important phase of

the potato industry for Canada is uniform production, certain and reliable yields. If these ends be first achieved, it is a very simple step to producing the surplus of potatoes required for manufacturing purposes. We are concerned with the elimination of harmful factors which prevent or interfere with the production of a desirable crop. Every effort has been made in recent years to increase production. The consumer will be the person to reply to the question whether or not the increased production of potatoes has been a success, especially in years of unfavourable weather conditions. What then are the reasons which make this very important crop more or less uncertain?

For a number of years we have endeavoured to find this out and we believe we can satisfactorily explain a large number of crop failures during the last few years. The farmers are almost unanimous in blaming the weather for crop failures. This is to some extent the case, no doubt, but the weather very rarely is to blame for so much as the farmer. The director of Experimental Farms has expressed his opinion recently in a manner that well may be brought to the attention of all farmers again and again:—

> "Only very rarely indeed need any farmer have a really poor crop, much less a total crop failure in Canada. The Canadian farmer who will do his work wisely and well each year and all the year round need seldom or never fear but that a crop fair to good at least, and usually excellent will generously reward his every well-timed and well-planned effort."

This is absolutely true of the potato crop.

Potato failures or low yields are due to a variety of causes. Firstly, to unsuitable varieties, or to the use of varieties for some inexplicable reason, which do not yield the highest returns. Secondly, to the use of inferior seed. Thirdly, to depreciation of the crop by diseases. Fourthly, to imperfect storing.

Naturally, failures are also directly due to faulty cultural treatment of the crop and to unfavourable weather conditions. The study of varieties, from the points of view of yield and local suitability, has been carried on by the Horticultural Division of the Experimental Farms for a large number of years. "Potatoes have been grown in a small plot," so the Dominion Horticulturist states, "at the rate of over 700 bushels per acre at the Central Experimental Farm, but so great is the difference in the yield of varieties that, while one gave this large yield, another, planted at the same time, and in the same kind of soil, yielded only 154 bushels." The importance of planting productive varieties is obvious, but it is by no means certain that a variety yielding well in one locality will do the same in another. One would have to choose the best variety or varieties and might have to change the seed from time to time. The Prince Edward Island farmers have one favourite variety—whether or not it is the heaviest yielder on the Island does not apparently matter, since they have peculiar markets. In New Brunswick two varieties are most prominent—they are called for by the shippers and have the name. Whether they are the best yielders apparently does not matter, so there is considerable conservatism in some localities about potato varieties. Perhaps this, too, will have to be overcome to make the general production more uniform. At any rate, it is most important to grow the best and heaviest-yielding varieties. To establish or build up a market for the same should not prove so very difficult once the superior quality is well known. The next point to consider and one which is of more interest to us from our point of view, is the use of superior seed. Superior seed comes from a vigorous, uniform and pure strain, and last but not least, from a crop free from transmissible diseases, or diseases carried by the seed potato.

Potato diseases are distributed throughout the Dominion and a very heavy toll is paid to them. Some provinces have their peculiar potato troubles, some diseases occur everywhere. Diseases should be eliminated, when getting seed ready for planting, and

when the potatoes are growing in the field. There are a number of very important diseases, which cannot be identified in the tuber, which, notwithstanding, appears quite sound.

Thus, the Mosaic disease of the potato easily accounts for 10 per cent losses (= 1,200,000 bushels) in New Brunswick alone. It occurs elsewhere just as seriously, and when reference is made here to a province by name it should be regarded as a favourable sign that such province has recognized and knows its foe—while others may not.

Black Leg, a disease which is most readily eliminated with very little trouble, still causes considerable damage, and there are scores of others ever increasing themselves, and ever decreasing the vigour of the potato.

Among the crop diseases the worst is Late Blight. This causes immense damage to the fields. We presume it is well known that spraying potatoes will control Late Blight, just as applications of Paris Green will kill the potato bug. Yet there are many farmers who still claim "it does not pay to spray my potatoes." "It may do so elsewhere, but not where we farm," is a common expression. True, in Ontario, Late Blight is reported to cause little trouble—some years there is hardly any—therefore, few Ontario farmers spray, and pay the penalty in seasons like the last. But it is known that diseases can adapt themselves to new conditions; it is, therefore, risky not to spray. Take New Ontario, for instance. It will be found that that immense country will become a potato country. There are no serious diseases there now, to speak of. But with indifferent methods there will be. Surely it is worth one's while to prevent the establishment of destructive diseases. In other provinces farmers claim it does not pay to spray, the cost of production is large enough as it is and the profits will all disappear when they do spray. That is not always correct. It has been demonstrated in our experiments on private farms that an increase in yield of from 50 to 100 bushels per acre may result from spraying. If that increase alone does not pay you, then look into a phase of the advantages of spraying which is not or has not been generally taken into consideration. A sprayed crop is a sound crop; the tubers will fully mature, they will be free from rot and keep well. No losses from storing will be experienced in such cases. The unsprayed crop produces premature or immature tubers full of rot in years of blight. What will be left of this after a winter's storage? We have found an average net profit per acre from spraying amounting to $34.38; in individual cases more, in others less.

The next point is the depreciation of the crop in storage. The systematic work carried on under the Destructive Insect and Pest Act has revealed to us losses in storage amounting to often fully 17 per cent of the total crop of a province. Individual farmers have lost more than half the crop in storage. The storage conditions need much improvement.

When all losses from various sources have been eliminated, we may then commence considering what to do with our surplus.

It is a fact which is meeting with more and more recognition that the best way of improving the potato industry is by the use of "better" seed. That is the fundamental improvement which is necessary; because better cultivation, manuring, fertilizing and even spraying are in part thrown away on crops of low vigour grown from poor "seed." If a farmer has clean stock of high productive power and plants it in suitable soil he need not worry about the many obscure potato diseases such as Mosaic, Rhizoctonia, Leaf Roll and others, which are the cause of so many weak stands, because if the "seed" is as productive as it should be they will not be present. Now, one never sees a crop in which all the plants are of equal vigour, and while the differences are not all attributable to the set, yet it is an experimental fact that sets which are the produce of the most vigorous plants will tend to give larger yields than those derived from less vigorous ones. At all events the continued use of superior sets will eventually eradicate all diseases which are carried in the tuber.

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The increased value of potatoes, coupled with a greater understanding of the importance of good seed, has created a demand for seed stock true to varietal character, of uniform vigour, free from diseases, and grown from prolific stock. This demand is well founded, and can be met only by vigorous rogueing and inspection of the potatoes in the field and in the cellars. A few growers are anxious to supply this market by producing potatoes of the best quality, but at the present time there is not sufficient of this stock to supply the present demand, which demand is bound to increase from year to year, as more interest is aroused among potato growers, knowing in a large measure where lie the undesirable factors.

It is therefore desirable to work along definite lines to effect improvements that will result in the elimination of all yield-decreasing factors. Good seed may be procured, or expected, from a crop free from diseases, of a good strain and vigour and of prolific yield. Since the seed potato bought in the market at the present time carries little or no guarantee that it is possessed of such desirable qualities, a start should be made in the field, by means of the application of a uniform method of field inspection that has been evolved after years of practical experience. Such a start will produce a quality of seed already much improved. One of the most striking features of a good many potato fields in the Dominion is the large percentage of foreign varieties to be met with in a field that should be composed of plants of one variety only. This feature is best observed at the time of flowering. Purity of variety is a very essential point. Every stray variety should be eliminated. Fields should be "rogued" for impurity of variety when the plants are in bloom, as the blossoms are frequently the only distinguishing characteristic. In practice, we have found it advisable to rogue, first, when the blossons are coming on, so as to catch early-blooming varieties, second, when in full bloom, and third, to catch late blooming varieties. In the case of some mixtures, such as Cumming's Pride and Irish Cobbler, it is difficult, if not impossible to recognise the rogues in this manner. However, they may be distinguished in the fall, as the Irish Cobbler matures early and the Cumming's Pride late.

If the impurities are more than 4 or 5 per cent and the consequent loss due to rogueing is very great, we recommend that only a part of the field (sufficient to produce pure seed for the next crop) be rogued or that the stray varieties be staked and dug up separately. All diseased or weak plants should be destroyed when pulling out stray varieties, and also later, from time to time, until the plants are mature, as many diseases become apparent just before maturity.

Experience indicates that a field should be rogued twice or more during the growing season. In fact it should be rogued regularly every two weeks from the blossoming period until the plants are practically mature, in order to get all the diseased plants and stray varieties.

Because of this necessity for frequent rogueing, the grower can accomplish it more easily, satisfactorily and thoroughly than can inspectors, who cannot visit a farm more than once or twice during the season.

Besides, such work should be done by the grower himself, since the conscientious man will always reap the benefit from the care which he has observed.

This practice of rogueing and field inspection carried on by the officers of this Division on a large number of farms has several particularly good features which are worthy of notice: (1) it should materially reduce the amount of disease present and improve the general stand; (2) by rogueing the field or a portion thereof a few times, we may succeed in getting the farmers themselves to take up the work; (3) it offers an opportunity of indicating to the farmers the amount of damage caused by disease, and of explaining methods of control; (4) it serves as a potato disease survey and enables us to determine which diseases are of economic importance; (5) field certification is a benefit to both the producer and the buyer. The producer is able to secure a price commensurate with the quality of his crop and the buyer knows that he is securing good stock for his money.

For several seasons we have practised such field inspection and for the use of the farmer and any other person who may desire to take up such work, we are publishing here the form used in our field inspection, from the study of which and its experimental application very valuable results may be achieved by the farmers themselves. They will easily be able to ascertain whether their present field of potatoes will have any chance to be considered worthy of recognition or not. At any rate it is strongly recommended to apply the requirements of this form to one's own crop uniformly all over the Dominion, where ultimately the good results are sure to become noticeable.

Dominion of Canada.

Division of Botany.

POTATO DISEASE CONTROL.

Field Inspection Report.

1. Name of farmer:

Address:

Road:

2. No. of field: Date of inspection:

3. Any inspection last year?

If so, do you notice any improvement this year (which indicate)?

4.	Name of Variety.	Area.	Seed used per acre.	When planted.	Percentage of other varieties.

5. Have all foreign varieties been removed?

6. Diseases observed (the exact percentage of each disease to be stated):

(a) *Serious Diseases:*	Remarks.
Black Leg.......... %	
Curly Dwarf.......... %	
Leaf Roll.......... %	
Mosaic.......... %	
Wilt Diseases.......... %	
Misses.......... %	

NOTE.—All individual hills showing symptoms of serious diseases should be removed in order to produce sound seed. If not removed field may be disqualified. Indicate in column "Remarks" whether or not removed.

(*b*) Less serious diseases (indicate as: absent, slight, moderate, severe).

Early Blight.
Late Blight.
Leaf Streak.
Rhizoctonia.
Tip Burn.
Other diseases or injuries observed which describe:

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7. Where was the seed obtained?
Have seed tubers been treated before planting?
What solution was used?
Strength of solution?
Length of time of treatment?
How was the seed cut (to one or more eyes each set or are whole tubers used)?
Are sets planted singly or not?
When was the seed changed for the last time?
How often is the seed changed?
NOTE.—Explain advantages of hill selection for vigour, strain and yield.

8. Has the crop been sprayed?
What solution was used?
Strength of formula?
How many times has been sprayed?
When commenced?
At regular intervals? What intervals?
When was the last spraying applied?

9. Control of potato beetles. (Indicate whether absent, slight, moderate, severe.)
What poison is being used?
What amount per application?
Is poison used in combination with spraying solution?
What amount is added to............gallons?
Any special application for beetles, before spraying was practised?
How many?

NOTE.—Hand grower a copy of Circular No. 9, "The Control of Potato Diseases," and advise him to follow the directions given.

10. Determine by count of section or sections of field accurate losses from diseases collectively from your list of individual diseases and calculate per acre—
One acre, how many plants?
How many diseased plants?
How many sound plants?
How many plants of other varieties?

11. Distance of rows apart?
Of plants in rows?
Planted in rows or furrows?

12. Nature of soil? Subsoil?

13. Situation of field (exposed, sheltered, slope, hill-top, low, in orchard, etc.)?

14. Condition of drainage (natural or artificial)?
In good working order? (If not, call attention to it).

15. Indicate clearly rotation followed:

16. General appearance of field (vigorous, lack of vigour, uniform height, lodging or erect, cared for or neglected):

17. How often cultivated?
Regularly or not?

18. Freedom from weeds (absent, slightly, moderately or very weedy):
Principal weeds:

NOTE.—If unable to identify, forward specimens to Dominion Botanist, Central Experimental Farm, Ottawa, attaching the number of the field and locality where gathered.

19. Have you any observations to make regarding conditions apparently favouring disease?

20. Describe weather conditions (normal, dry, excessively dry, wet, excessively wet, etc.)

NOTE.—A separate form to be used for each variety.
Signed:

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As there are diseases in potatoes not recognizable in the tuber, so there are such diseases as Common Scab, Powdery Scab, Late Blight, Tuber Rot, Dry Rot, etc., that can only be determined from an inspection of the potatoes themselves after harvest. For this purpose a fall or tuber inspection is necessary and the following inspection form is recommended.

1. Name of farmer:
2. Post Office address:
3. Road:
4. Number and date given to field on inspection in summer No........

   Date ....
5. Variety:

   Area planted: Yield in bushels:
6. Diseases observed on examining each tuber of a total of 500 tubers selected to represent bulk:

(a.) *Serious Diseases:*	1st I.	R.-I.	Remarks
Deep stem end browning *Verticillium albo-airum* and *Fusarium oxysporum*..................	%		
Bacterial Rots..................	%		
Dry Rot (*Fusarium* spp)..................	%		
Late Blight Rot..................	%		
Powdery Scab..................	%		
(b). *Less Serious Diseases:*			
Common Scab..................	%		
Net Necrosis..................	%		
Rhizoctonia..................	%		
Silver Scurf..................	%		
Other internal diseases (which describe)..................	%		

7. Determine if possible whether disease increased during storage; use column remarks for report.
8. If more than 10 per cent of the serious diseases collectively, these comprising:
   In summer report: Black Leg, Curly Dwarf, Leaf Roll, Mosaic, Wilt Diseases; or more than 5 per cent "misses."
   In fall report: Deep Stem End Browning, Bacterial Rots, Dry Rot, Late Blight Rot, Powdery Scab.
   If more than 10 per cent "less serious" diseases individually, these comprising:
   In summer report, none;
   In fall report; Common Scab, Net Necrosis, Rhizoctonia, Silver Scurf, and other internal diseases.
   No certificate will be granted.
   (If Common Scab, Rhizoctonia, Silver Scurf is in excess of 10 per cent farmers may secure recognition of their crop, providing they are willing to remove the diseased tubers in excess. Then re-inspection will be necessary.)
9. Re-inspection date: (Enter findings in column R.-I.)
10. Where are the potatoes stored?
11. Describe conditions for storage: Disinfected:
    Ventilation good: poor:
    Temperature when examining?....................°F.
    Likely to vary? Considerably, little?
    Any idea of minimum: maximum: temperature?
12. Amount stored: date placed in storage:
13. How many used?
14. How many lost in storage?
15. Certificate was granted (a) at time of first inspection.
    (b) at time of second inspection.

Signed:

Plant Disease Inspector.

Date:

(This form to be attached to field inspection report).

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The following is an account of work done along these lines in Prince Edward Island under the supervision of Mr. Murphy, and in New Brunswick, where it was in charge of Mr. Cunningham. Since these gentlemen will have charge of such work in Nova Scotia and Quebec respectively, the work will be extended in these provinces, and since the Ontario Department of Agriculture, at our suggestion, has also requested its district representatives to inaugurate this work for Ontario, the results promise to become highly interesting in a few years.

Mr. Murphy reports:—

A campaign was inaugurated in Prince Edward Island during the past season to impress the importance of these facts on the potato growers of the province. Inspectors who were thoroughly familiar with the question were sent to certain districts with instructions to explain the scheme to the growers and help them to obtain better "seed." It must be explained here that the problem of potato raising on the Island is not a simple one. While the country, on account of its situation and climate, is an ideal one for the crop, not second to any with which the writer is acquainted, the industry is limited by two factors—in the first place, by transit difficulties, which compel the export of the bulk of the crop in October, November and part of December, which in itself is an unfavourable time, a glut being easily caused on a market which is limited owing to the fact—and this is the second reason—that the variety almost universally grown is hardly a marketable commodity either for planting or eating outside Prince Edward Island itself and parts of Nova Scotia and Newfoundland. This confined our efforts in the "seed" potato business to filling the needs of the Island alone, but small as these are, it was an imperative necessity for the betterment of the industry. The plan which seemed to promise the best results was to go to the best districts and interest some of the growers in rogueing their crops, if their condition as regards disease warranted such a step. The inspectors were instructed to place their services at the disposal of the growers in carrying this out, not merely to mark the plants, but to take them out. This state of each crop was reported on suitable forms, the percentage of diseases present being recorded, as well as the amount of foreign varieties. Each crop was afterwards examined in the cellar and reported on in a similar way. The next step was to place those whom we had found to have good "seed" in touch with those who were in need of such, so far as we knew, and thus it was hoped in time to build up a small "seed" potato business within the Island, which would ensure a supply of good stock when it was required, and give some of the best growers an outlet and a market for their energy.

Considerably over one hundred farms were visited and a propaganda was carried on which will in time bear fruit. Further, a large amount of useful information and statistics based on actual counts of the amount of various diseases occurring in each crop were accumulated. The value of this is very great. Otherwise, the very abnormal season dealt the scheme a heavy blow. There has never been any domestic seed potato trade to speak of, and growers have not been in the habit of holding over stocks when a market could be found; so when prices advanced in the fall almost the entire available surplus, so far as one can judge in the absence of statistics, was exported. Further, those who had good stock would not hold it except in the hope of obtaining prices considerably in excess of the market rate, and as the latter was even then twice as high as the average price it was not to be expected that other growers would pay a doubly enhanced price for better stock so long as they had some of their own, no matter how poor.

One year's experience of the work has shown also that though it might be slower to induce each individual grower to select his own "seed" instead of getting a few men to select, and urging the others to buy from them, yet the educational effect of the former method would be very great and would probably compensate for the greater length of time required to attain equally widespread results. It is intended to continue the scheme in a modified form during the coming season.

Ottawa.

Mr. Cunningham reports:—

During the summer of 1915, the Division of Botany inaugurated a system of rogueing and field inspection as an aid to better potato production and as a means of endeavouring to meet these requirements. As a result, many applications have been received at this laboratory during the past winter and spring for information concerning the possible sources of good seed stock, which has been certified to by Government inspectors. The system which has met with such singular success during the first year, will be continued on a more extensive plan, as well as along improved lines, during the coming season, in conjunction with the work of the New Brunswick Potato Growers' Association.

During the past season, very few farmers failed to accept our offer to rogue their fields; all seemed anxious to receive and apply methods suggested by us for the improvement of their potato crop. Over one hundred fields in New Brunswick were rogued for impurities and diseased plants. The crops from thirty-three of these have been strongly recommended to prospective buyers as suitable for seed. A large number more were visited, but, because of the prevalence of disease or varietal impurities, reports were not made.

Potato spraying experiments.—"A." Account of experiments in New Brunswick by Mr. G. C. Cunningham, B.S.A., assistant in charge of Field Laboratory of Plant Pathology, Fredericton, N.B.

Two series of potato spraying experiments were conducted during the past season to determine the value of Bordeaux mixture when used under New Brunswick conditions. This seemed advisable, since there is some doubt as to its value under all conditions, particularly during years when Late Blight is absent.

The first series consisted of spraying potatoes growing on the different fertilizer plots at the Dominion Experimental Station, Fredericton, to determine whether or not the different fertilizers applied had any influence on the response of the potatoes to spraying with Bordeaux mixture. This, of course, will have to be continued for several years before any definite conclusions may be drawn, but the results secured this year are so striking, that it seems advisable to mention them here. The results clearly indicate that spraying materially increased the yields during the past season on nearly all of the test plots. The unsprayed section of plot 45, which was fertilized by applying 66½ pounds nitrate of soda, 50 pounds sulphate of ammonia, 186 pounds basic slag, and 50 pounds muriate of potash, gave 2⅚ bushels more potatoes per acre than the sprayed section. With this exception, all sprayed sections of the plots gave larger yields than the unsprayed sections. The largest increase was 103⅔ bushels per acre. This was obtained on plot 9, which was fertilized with 80 pounds nitrate of soda, 60 pounds sulphate of ammonia, 343 pounds acid phosphate, 343 pounds basic slag, and 120 pounds muriate of potash per acre. The average yield from the sixty-nine sprayed plots was 205 bushels per acre as compared with 163 bushels per acre from the sixty-nine unsprayed plots. This shows that there was an average increase, due to spraying, of 42 bushels per acre. No further conclusions are justifiable until further information has been obtained.

The second series of spraying experiments was conducted on farms in different sections of the province on ordinary field crops and also on the field crop at the Dominion Experimental Station, Fredericton, for a three-fold purpose: (1) To prove the value of spraying potatoes with Bordeaux mixture under New Brunswick conditions; (2) to determine the number of applications necessary in order to secure the best results; (3) to serve as illustration experiments conducted under farm conditions. These experiments were conducted on the farms of Mr. Fred. Warnock, Grand Falls, N.B., Dr. L. McIntosh, Hartland, N.B., Mr. A. B. Blackie, Woodstock, N.B., and on the Dominion Experimental Station, Fredericton, N.B.

On the farm of Mr. A. B. Blackie, 1¼ acres of Irish Cobblers and 1 acre of Green Mountains were set aside for experimental spraying. The Irish Cobbler patch was

divided into three sections; one sprayed three times, one twice, and a third left as a check, or unsprayed. The Green Mountain area was divided into five sections; one sprayed four times going both ways on the row, one sprayed four times, one three times, one twice, and one left as a control.

On the farm of Dr. McIntosh, Green Mountains and Irish Cobblers were sprayed, but owing to the influence of several factors which could not be controlled by spraying, these experiments were unsatisfactory and are not included in this report.

On the farm of Mr. Fred. Warnock, 1 acre of Carman No. 1 was set aside for experimental spraying. It was divided into four sections which were sprayed similarly to the Green Mountains on the farm of Mr. Blackie, except that the fourth application was omitted because of wet weather.

These plots were sprayed as nearly as possible at intervals of two weeks, but, owing to the wet weather, it was sometimes impossible to carry out this schedule. The spraying was started on July 23 and continued at intervals of two weeks until the required number of applications had been made.

Between the dates of the second and third applications, Late Blight became very prevalent and, as a consequence, the plants in unsprayed areas were killed to the ground. The sprayed areas were slightly affected in a few places, but the third application of the Bordeaux mixture checked the spread of the disease. By the last of August, the sections which were sprayed twice were badly infected and rapidly dying, while only slight traces of the disease could be found on the sections sprayed three times.

The Cobblers, in nearly every case, matured before the fourth application was made. The Green Mountains, which received four applications, and Carman No. 1, which received three double applications, were comparatively free from infection when examined on September 16. However, where the rows were sprayed four times both ways, there was only a minimum of the disease.

The results show that four or more thorough applications of Bordeaux mixture practically controlled the disease and gave markedly increased yields. Practically the same conditions existed on the plots sprayed at the Dominion Experimental Station, Fredericton. It should be noted however, that spraying was not commenced until the plants were quite large and better results might have been secured had the work been started earlier in the season.

The following tables give the results obtained from spraying with Bordeaux mixture on the different farms:—

RESULTS OF SPRAYING POTATOES ON THE FARM OF A. B. BLACKIE, WOODSTOCK, N.B.

IRISH COBBLERS.

Treatment.	Marketable per acre.	Small per acre.	Total per acre.	Difference in marketable per acre	Difference in total per acre.
	Bush.	Bush.	Bush.	Bush.	Bush.
Sprayed three times	208	38½	246½	34	40½
Sprayed twice	190	43½	233½	16	27½
Unsprayed	174	32	206		

GREEN MOUNTAINS.

Treatment.	Marketable per acre.	Small per acre.	Total per acre.	Difference in marketable per acre	Difference in total per acre.
Sprayed four times both ways	109	9½	118½	54½	46½
Unsprayed	54½	17½	72		
Sprayed four times	95	6	101	40½	29
Unsprayed	54½	17½	72		
Sprayed three times	89	6	95	34½	27
Unsprayed	54½	17½	72		
Sprayed twice	79½	13½	93	25	21
Unsprayed	54½	17½	72		

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RESULTS OF SPRAYING ON THE FARM OF F. W. WARNOCK, GRAND FALLS, N.B.

CARMAN No. 1.

Treatment.	Marketable per acre.	Small per acre.	Total per acre.	Difference in marketable per acre	Difference in total per acre.
	Bush.	Bush.	Bush.	Bush.	Bush.
Sprayed three times both ways..........	267	14½	281½	220½	162½
Unsprayed..............................	46½	72½	119		
Sprayed twice both ways................	218	43½	261½	171½	142½
Unsprayed..............................	46½	72½	119		

RESULTS OF SPRAYING POTATOES ON THE FIELD PLOTS AT THE DOMINION EXPERIMENTAL STATION, FREDERICTON, N.B.

PLOT No. 1, GREEN MOUNTAIN.

Treatment.	Marketable per acre.	Small per acre.	Rot. per acre.	Total per acre.	Difference in marketable per acre	Difference in total per acre.
	Bush.	Bush.	Bush.	Bush.	Bush.	Bush.
Sprayed....................	221	29	¾	250¾	78½	84¾
Unsprayed..................	142½	22	1½	166		
PLOT No. 2, GREEN MOUNTAINS.						
Sprayed....................	212	22½	½	235	47	46
Unsprayed..................	165	22½	1½	189		
PLOT No. 3, IRISH COBBLERS.						
Sprayed....................	258	31	2	291	68½	62½
Unsprayed..................	189½	35½	3½	228½		

"B." Account of experiments in Prince Edward Island, by Mr. P. A. Murphy, B.A., assistant in charge of Field Laboratory of Plant Pathology, Charlottetown, P.E.I.:—

The principal experiment was carried out on the farm of Mr. A. E. Dewar, Charlottetown, to whom the author is much indebted for the results attained. The conditions were ideal for experimental purposes, as the potatoes were planted in narrow plots between the rows of trees in an orchard, thus facilitating spraying with different mixtures and minimizing the spread of blight from one plot to the next.

The experiment was divided into two parts, the first being designed to test the effect of Bordeaux mixture of the 6:4:40 formula against unsprayed plots. There were twelve plots, six sprayed and six unsprayed, the varieties used being Green Mountain, Dakota Red and McIntyre. On account of the way in which the varieties were planted, it was necessary to arrange the sprayed plots and the corresponding

checks end to end instead of side by side. While it is possible that soil variation may have influenced the result under this arrangement more than if the plots were side by side, yet it is unlikely, on account of the known uniformity of the ground, the number of plots, and the fact that the checks were placed alternately at the north and south ends of the rows.

Spraying was carried out five times, at intervals of two weeks, with Bordeaux mixture made up of 6 pounds of copper sulphate, 4 pounds of quick lime and 40 gallons of water. It was applied with a knapsack sprayer and sufficient was used on each occasion to cover the foliage very thoroughly. The amount per acre varied from 100 to 200 gallons. The last spraying, which was applied on September 24, was probably of little or no use, as the plants were killed by frost a few days afterwards. The first spray was put on on July 29, a date which was unavoidably late, and which, though it antedated the open appearance of the blight by a considerable time, may explain why the increase in yield was not even greater than was obtained.

TABLE I.—Showing the effect on potatoes of five sprayings with Bordeaux mixture as against similar potatoes unsprayed, the yields being given in terms of plots of one-fortieth of an acre.

Plot.		Variety.	Yield per one-fortieth acre in pounds.			Increase in marketable potatoes per one-fortieth acre plot. pound.
No.	Treatment.		Late blight rot.	Market-able.	Total.	
2·1	Bordeaux	McIntyre	0·0	260·5	342·5	151·5
2·2	Check	"	1·0	109·0	196·0	
4·1	Check	Green Mountain	2·0	147·0	220·5	
4·2	Bordeaux	"	1·5	343·0	417·5	196·0
5·1	Bordeaux	"	0·0	370·0	409·0	168·0
5·2	Check	"	0·0	202·0	248·0	
6·1	Check	Dakota Red	0·0	279·0	333·0	
6·2	Bordeaux	"	0·0	374·0	418·0	95·0
7·1	Check	"	0·0	228·0	336·0	
7·2	Bordeaux	"	0·0	418·5	466·5	190·5
8·1	Bordeaux	"	0·0	420·0	458·0	72·0
8·2	Check	"	0·0	348·0	420·0	

The next table, II, gives the same results in terms of an acre together with the value of the increase and the net profit due to spraying. The actual cost of the operation was used in making this calculation although the work was done by hand and on an experimental scale. To spray one acre five times as we did it cost $14.12, whereas with the price of materials as it was last season the cost should not have been much in excess of $8, or $1.60 per acre per spraying, that is assuming that the work were done on a larger scale and in the most economical manner possible. It should be borne in mind also that the profit given represents merely the increased profit due to spraying after the cost of the operation has been paid for. To obtain the total profit this figure should be added to whatever profit was realized in growing the potatoes in the check plots.

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TABLE II.—Showing the effect on potatoes of five sprayings with Bordeaux mixture as against similar potatoes unsprayed, the increase in yield and profit being given in terms of one acre.

Plot. No.	Plot. Treatment.	Variety.	Increase in marketable potatoes due to spraying.	Value of increase at 50 cents per bushel.	Net profit per acre from spraying.	Average net profit per acre from spraying.
			Bush.	$ cts.	$ cts.	$ cts.
2·1	Bordeaux	McIntyre	101·0	50 50	36 38	
2·2	Check	"	......	......	......	
4·1	Check	Green Mountain	......	......	......	
4·2	Bordeaux	"	131·0	65 50	51 38	
5·1	Bordeaux	"	112·0	56 00	41 88	
5·2	Check	"	......	......	......	
6·1	Check	Dakota Red	......	......	......	34 38
6·2	Bordeaux	"	63·0	31 50	17 38	
7·1	Check	"	......	......	......	
7·2	Bordeaux	"	127·0	63 50	49 38	
8·1	Bordeaux	"	48·0	24 00	9 88	
8·2	Check	"	......	......	......	

The result of this experiment shows conclusively that in a season like that of 1915, spraying potatoes is a profitable undertaking in Prince Edward Island. To the question which is so often asked, "Can we afford to spray our potatoes?" it gives the answer that you can scarcely afford to grow them without spraying because spraying is responsible for the bigger share of the profit. It has been objected that the problem is a peculiar one in that province firstly because the variety grown is said to be very resistant to the blight and that only in an abnormal season like that of 1915 is it seriously affected. As to this point the author is unable to speak from experience, but the fact that spraying increased the yield of that variety at the rate of 101 bushels per acre, or 4 bushels more than the average of the three varieties combined, indicates that it is not highly resistant. On the other hand, it is said that the selling price of potatoes is so low as a rule that such an expensive treatment would not pay. This is a point which remains to be seen. However, if we venture on an estimate and assume that a farmer is more likley to obtain an increase of 50 bushels per acre than 97 bushels on account of less thorough spraying, and if we assume also that five sprayings cost $8 per acre, then if potatoes sell for 25 cents a bushel the net profit due to spraying (over and above whatever profit might be realized from growing them unsprayed) would be $4.50. It is unfortunately a fact, however, that with copper sulphate at its present price the cost of five sprayings will be much in excess of that amount, so much so indeed that potato spraying is not now an economical proposition. It is safe to state that in this province under average conditions it does not pay to spray this crop when copper sulphate costs more than 15 cents per pound.

Comparison of Bordeaux mixture and Kil-tone.—"Kil-tone" is a ready-to-use Bordeaux paste, made presumably by precipitating the copper in a solution of copper sulphate by means of lime in some form, the sale of which was pushed considerably in the Maritime Provinces last season. It much resembles the preparation put on the market in England under the auspices of S. U. Pickering, F.R.S., and known as "Woburn Paste", but whether it is manufactured in the same way, by the use of lime

water instead of milk of lime, the writer was unable to discover from the representative of the makers.

A liberal supply was placed at the disposal of the Field Laboratory for experimental purposes, and, as it was a matter of importance to determine if this substance with which a number of farmers were being induced to spray, practically all for the first time, were of real utility, the officer in charge undertook to test it against plots sprayed with Bordeaux mixture and unsprayed check plots. The experiment was carried out at three centres, one being on the same farm as the Bordeaux experiment and the others on the farms of Mr. J. A. Taylor, Wilmot road, and Mr. D. Reid, near Summerside. The plots at the last centre were accidentally disturbed during the course of the season and for that reason the results are not included in the report.

The Bordeaux mixture used was made up according to the 6–4–40 formula (6 pounds of copper sulphate, 4 pounds of quick-lime and 40 gallons of water), and it was used five times at intervals of two weeks beginning July 30. Sufficient spray was applied in each case to cover all the foliage thoroughly. The Kil-tone was made up according to the makers' directions and was applied as nearly as possible in the quantities they recommend. It was found, however, that to cover all the tops even moderately well with a knapsack sprayer called for the use of larger quantities than they stated, and sufficient was used to give all the foliage a coating. Both Bordeaux and Kil-tone were applied throughout on the same day. The plots were arranged in the Dewar experiment somewhat as described for the Bordeaux plots, the first series reading from north to south Kil-tone–Check–Bordeaux, and the second series reading in the same direction Bordeaux–Check–Kil-tone. The plots were side by side in the Taylor experiment (9.1, 9.2, 9.3).

Table III.—Showing the relative effect of spraying potatoes five times with Bordeaux mixture and five times with Kil-tone, as against unsprayed potatoes, the yields being given in terms of plots of one-fortieth of an acre.

Plot.		Variety.	Yield per fortieth acre in pounds.			Increase in marketable potatoes per fortieth acre plot.
No.	Treatment.		Late blight rot.	Marketable.	Total.	
						Lb.
1·1	Kil-tone	Green Mountain	13·75	364·0	443·0	217·0
1·2	Check	"	8·25	147·0	224·0	
1·3	Bordeaux	"	0·0	419·0	470·0	272·0
3·1	Bordeaux	Early Rose and McIntyre	0·75	318·0	354·0	153·0
3·2	Check	"	16·75	165·0	209·0	
3·3	Kil-tone	"	0·0	309·0	366·0	144·0
9·1	Bordeaux	McIntyre	0·0	238·5	297·0	67·0
9·2	Check	"	0·0	171·5	228·5	
9·3	Kil-tone	"	0·0	223·0	280·0	51·5

TABLE IV.—Showing the relative effect of spraying potatoes five times with Bordeaux mixture and five times with Kil-tone, as against unsprayed potatoes, the increase in yield and profit being given in terms of one acre.

Plot. No.	Plot. Treatment.	Variety.	Increase in marketable potatoes due to spraying.	Value of increase at 50 cents per bushel.	Cost of spraying per acre.	Average net profit per acre from spraying.
			Bush.	$ cts.	$ cts.	$ cts.
1·1	Kil-tone	Green Mountain	145	72 50	15 88	56 62
1·2	Check	"	......	......	......	
1·3	Bordeaux	"	181	90 50	14 12	76 38
3·1	Bordeaux	Early Rose and McIntyre	102	51 00	14 12	36 88
3·2	Check	"	......	......	......	
3·3	Kil-tone	"	96	48 00	15 88	32 12
9·1	Bordeaux	McIntyre	45	22 50	14 12	8 38
9·2	Check	"	......	......	......	
9·3	Kil-tone	"	34	17 00	15 88	1 12

TABLE V.—Summary of comparison of Bordeaux mixture and Kil-tone, showing increase in yield, cost of spraying and profit from spraying per acre.

—		Bordeaux mixture.	Kil-tone.
Average increase in marketable potatoes over checks	Bush.	109	92
Difference in favour of Bordeaux mixture	Bush.	17	.....
Cost of spraying	$	14 12	15 88
Average net profit from spraying	$	40 55	29 95
Difference in favour of Bordeaux mixture	$	10 60	.....

These tables speak for themselves. Kil-tone is retailed in small quantities in Prince Edward Island at 17 cents per pound, copper sulphate being sold under the same conditions at 11 cents or less per pound. The relative cost of these two substances would hardly be very different in more normal times. As a result of the higher price, it cost us $15.88 to spray 1 acre five times with Kil-tone, whereas spraying five times with much larger quantities of Bordeaux mixture cost $14.12. To this difference must be added the lower efficiency of the prepared substance, valued at the price of 17 bushels of potatoes, making in all a figure of $10.60 in favour of Bordeaux mixture. Thus is added another testimony to the fact that there has not yet been discovered a compound which will compare in cost or efficiency with home-made Bordeaux mixture for spraying potatoes.

THE EFFECT OF WET SEASONS ON GRAIN.

(*Plate LVII a-f*) *Sooty ear of wheat.*—A large number of samples of wheat have been received from the West in the laboratories of this Division, showing a more or less pronounced sooty appearance or black specks covering the ears. Field observations were also made during the latter part of the season in Ontario and the Maritime Provinces, which revealed the same conditions; in some instances the whole wheat plant in the stook was almost black.

It is quite natural that farmers, finding their wheat assuming this colour, should become very anxious and eagerly seek advice. Since these conditions seemed to prevail universally this season, the following account has been prepared with a view to assure farmers that these conditions are primarily of a seasonal nature, and only in rare instances will they cause material losses. The discoloration is exclusively due to ..ain micro-fungi, of which the development is greatly favoured during wet seasons.

The commonest fungus of all is *Cladosporium,* probably the widely distributed species *herbarum* of Link. This causes the "sooty ear" proper. According to the quantity of fungus material present, the ears of wheat will appear either as if wholly covered with soot or as if speckled with it.

Generally speaking, "sooty ear" will appear in wheat that has been cut and exposed for a time to moist or rainy weather. Sometimes this condition will appear on the uncut wheat, particularly when the grain is nearly mature and rain prevents harvesting.

The same phenomenon is also known to occur before maturity of the grain, and may at times be directly due to excessive rains, but more often to the premature death of the leaves following upon summer drouth, which causes the grain to ripen prematurely and assume a shrivelled appearance. Indeed, this look is imparted by almost any agent which causes the premature death of wheat plants.

In all the instances referred to this fungus appears as a secondary symptom and inflicts little or no damage on the grain itself.

It is very doubtful whether the fungus ever causes grain to become shrivelled. Some observers have so recorded, but the evidence is not at all conclusive. We personally have not been able to attribute any losses of grain to this fungus. Still it is not unlikely that when exceptionally moist weather occurs during the flowering period of wheat, this fungus may appear and frustrate the pollination of the ovary and thus cause only imperfectly developed grain. In rare instances, however, the fungus will produce discoloration of the grain itself, when left too long in the ear on the field.

Since it is impossible to prearrange suitable weather, it is equally impossible to suggest any means of preventing this condition. It may be advisable, when periods of wet weather have been forecasted, to cut the wheat a little early and endeavour to bring it into the barn or other shelter before it is exposed to prolonged rains. When, however, rain falls continuously while the wheat is in the stook, farmers should do their best to hasten the drying of the grain by frequent turning over of the sheaves, or by using rainproof covers for grain of special value or for special purposes.

The appearance of the ears, however, is really more alarming than the damage done warrants.

Glume spot of wheat.—Another entirely different kind of ear discoloration was also being met with this year. It was observed in the growing plant, but would, of course, show also in plants in the stook. In this case the ears showed no sooty mould; but the glumes, or seed-covering scales, showed reddish-brown to chocolate-brown spots, giving the affected ears a much darker appearance than that of the sound ones. This "glume spot" is common in Europe and has been frequently observed by other investigators as well as ourselves on this continent. Towards the end of the season these spots show minute fruiting bodies filled with numerous spores. The fungus has been identified as *Septoria glumarum* Pass. The fungus rarely penetrates to the grain, hence does little or no damage to the crop. It is especially common during wet seasons.

Wheat scab.—The popular name which has been given to this disease is not as descriptive as could be desired, since our interpretation of scab is something very different from this appearance. In the Maritime Provinces wheat scab was apparently common this year, but the damage was slight. Its effect on the plants is more apparent than real. Farmers observing this trouble in their wheat are naturally

anxious about it, but they can be assured that the damage which this disease causes in the Dominion is negligible. We have found it causing about 1 per cent loss; no doubt continued rainy weather may be responsible for greater damage.

The appearance of the diseased heads is very characteristic. We can invariably recognize the disease by the bluish-brown discoloration of the haulm just below the ear for about 2 to 3 inches. If such an ear is cut off and the spikelets examined, there will be no difficulty in detecting at the base of some of them a fine rose-coloured deposit apparently growing from below the covering scale or glume. The affected spikelets, and the grain contained therein, are dead. Sometimes the central portion of a whole ear is killed off, sometimes all the portion above the infection is dead, while below the infection the grain may still be normal.

The disease is widely distributed in Canada. The fungus to which the production of the reddish deposit is due was long known as *Fusarium roseum* Link., but since the perfect stage of the fungus has apparently been discovered, the disease has received the name *Gibberella Saubinettii* (Mont.) Sacc.

It is not unlikely that partly infected grain on germinating may be destroyed by fungus mycelium, but we have no evidence to cause us to believe that the disease is conveyed by diseased grain. Were this the case, the damage would be sure to be considerable. But, apparently, the fungus being a very common one in nature, attacks wheat from the exterior by wind-borne spores, and here is where continued moist or rainy weather exerts its favourable influence on the development of this fungus disease.

"Bitter Pit" or "Fruit Pit" of Apples.—In the botanist's report for the year 1910-11, p. 244, was published a preliminary note on Bitter Pit, accompanied by plate IX A. In the report for 1911-12, p. 205, reference was made to the same trouble and the researches of Dr. Jean White and Professor Ewart of Australia were briefly reviewed. Later, in the 1913 report, p. 489, a review was given for the benefit of the Canadian fruit growers of Professor D. McAlpine's (of Australia) first report on his Bitter Pit investigations. Professor McAlpine's final report has now been received through the courtesy of Mr. D. H. Ross, Trade Commissioner of the Canadian Government, Melbourne, Australia. Since the disease is of uncommon interest to the Canadian fruit growers, to whom it annually causes very considerable losses, it will be of interest to acquaint them briefly with the recommendations made by Professor McAlpine, which he has shown will largely prevent this serious trouble.

The reports themselves are very voluminous, and an abundance of work is recorded. They comprise four volumes of 775 pages text and some 170 plates with more than 400 figures, which doubtless constitute a record publication on the subject of one disease.

As a result of careful experiments and an exhaustive study, Professor McAlpine's conclusions may be summarized as follows:—

"In picking and packing, apples should be handled as carefully as eggs, the slightest bruise will produce a flaw in the flesh.

"Trees should not be allowed to bear too early. Respiration of the fruit is slowed down at 32° F.; keeping fruits at that temperature will retard Bitter Pit. This temperature also arrests the ripening process. A uniform cold storage temperature ranging from 30° to 32° F. will prevent freezing of the fruit and will prevent Bitter Pit from developing. Temperature variations must be avoided. Varieties vary considerably in their susceptibility. Fruit growers are advised to select the best immune commercial varieties for the district, when planting new orchards. Excessive supply of nitrogen encourages pitting. Ploughed under cover crops seem the best sources of supply for nitrogen. Steady rather than spasmodic growth should be aimed at. If the soil is in good condition and well cultivated, manuring should be necessary only when the trees come into full bearing. The necessary phosphoric acid and potash should be

supplied every year—the phosphoric acid as superphosphates of lime, and the potash as sulphate of potash. Low-lying swampy land favours Bitter Pit; well-drained land tends to lessen it.

"Severe pruning produces a virulent form of pit, whereas light pruning is a reducer of pit, or prevents it altogether. Artificial irrigation—the sudden change from dry to wet conditions is the best known means of producing Bitter Pit—should be practised during the fruiting season only when necessary to equalize the moisture contents of the soil. Uniform moisture supply is very important to prevent Bitter Pit.

"In order to reduce Bitter Pit to a minimum, it is necessary to have the tree well shaped, so as to be equally developed all round, to prune it so that the fruit is evenly distributed over the tree and not confined to a few main branches. Regularity in size and growth and ripening is very important."

We quite agree with Professor McAlpine's advice. Although the climatic and other conditions of Australia may vary considerably from those in Canada, it is most judicious to aim at the "regulation of forces" suggested by this author. We err too often in the correct treatment of our orchards. Nature aids herself; man—in introducing apple culture where formerly wild shrubs or forests grew—must be patient and study the requirements of the trees, under which they will best perform their natural functions of growth and development. Then, only, such troubles as Bitter Pit will slowly disappear. It would be of invaluable assistance to the success of eliminating Bitter Pit, if fruit growers would record and inform us of the resistance of varieties in their particular regions. (see Plate LVIII).

III. ECONOMIC BOTANY.

(By John Adams, M.A., *Assistant Dominion Botanist.*)

During the year, 1,439 specimens were received for identification. As compared with 955 for the previous year this represents an increase of 50 per cent. Some were sent in during each month of the year and every province of Canada was represented, including the Yukon Territory. A number of specimens had to be forwarded to the Royal Botanic Gardens, Kew, England, for identification, as there were no similar specimens in the herbarium or arboretum to compare with them. A considerable number of the specimens sent in were weeds and information was desired on the means of eradicating them. In many cases inquiries were also made as to the best method of destroying noxious weeds by means of chemical sprays, etc.

There was also a considerable number of plants sent in which were either poisonous or were suspected of poisoning live-stock. One farmer in British Columbia reported having lost thirty-six horses and sixty-five cattle in six years. Another farmer in British Columbia reported the poisoning of his milch cows by Loco weed (*Oxytropis Lamberti Pursh.*) A farmer in Prince Edward Island had five cattle poisoned, and there was a number of other cases of poisoning in other parts of the country. Among the poisonous species sent in during the year were *Veratrum viride* Ait., *Zygadenus venenosus*, S. Wats., *Daphne Mezereum* L., *Cicuta Douglasii* Coult. and Rose, *C. maculata* L., *Oxytropis Lamberti* Pursh., *Kalmia angustifolia* L., *Datura Stramonium* L., *Hyoscyamus niger* L., *Solanum nigrum* L., *S. Dulcamara* L. There were also several requests for literature with reference to poisonous plants.

Among the plants received for identification was a number of species of seaweeds. The extraction of potash from the larger kelp-weeds is a subject of considerable economic importance at present, but we have no specimens or literature to serve as a guide in identifying plants of this group.

A large number of requests was received for Bulletin No. 23 on Medicinal Plants, and many inquiries were received from persons who wished to know the names of

seedsmen and nurserymen who stocked medicinal plants; others desired information regarding the addresses of firms who purchased drug-plants. In a few cases we were able to supply seeds of these plants to those who wished to try them.

A beginning was made in the culture of medicinal plants and seeds of different species were sown. Henbane behaved as an annual; belladonna and marshmallow flowered and fruited the same year as sown and survived the winter satisfactorily. Spearmint also made considerable growth during the first year, although it did not flower, and is apparently also quite hardy. Fennel, tansy and rue grew well and have survived the winter successfully. The snowfall was excessive and consequently it will be necessary to continue observations for a few years before drawing any general conclusions about winter-killing.

A number of inquiries was received in reference to the culture, etc., of wild rice, chicory, and mustard. As chicory must be dried before it is ground, its cultivation can only be profitably undertaken by farmers within reach of a drying-kiln. The demand for this article is limited and as the roots are heavy, the freight on undried roots for any considerable distance would be excessive. At present, in Eastern Canada, the roasting of chicory appears to be carried out by only one firm in the province of Quebec. Mustard appears to be a more satisfactory crop, as the seeds occupy but little space and the freight, even to a more distant market, is lighter in proportion to the value of the product. Both chicory and mustard, however, like medicinal plants, belong to the class of special crops and should only be grown by those who manufacture them in sufficient quantity to meet the popular demand. Unless a farmer can arrange with a manufacturer beforehand as to the quantity required and the approximate price it is rather a hazardous experiment to grow any of these crops unless in very small quantities.

Numerous inquiries were received from persons in different parts of Canada about books and literature dealing with the flora of their respective provinces. Many of these were doubtless teachers, and it is encouraging to see the interest manifested in the study of native plants. It is somewhat disappointing to have to reply that with the exception of some general works and bulletins of a somewhat limited scope dealing with the commoner weeds, there are no modern books dealing in an exhaustive manner with the different provinces and written in such a way as to be especially suited to teachers.

Many inquiries of a miscellaneous nature were received during the year, such as the manufacture of essential oils from various plants, the vitality of weed seeds in the soil, the removal by chemical methods of low forms of plant life (algæ) in water reservoirs, etc.

Every year some letters and specimens for identification are received, but the sender omits to sign his name or to enclose a slip stating whom the specimens are from. Disappointment must inevitably ensue, but it is evident that the responsibility does not rest with this Division.

There was a considerable amount of correspondence relating to the growth of flax for fibre and the utilization of waste flax-fibre for industrial purposes. In answer to a request from the Superintendent, specimens of flax straw, retted and unretted, and flax fibre were sent to the Museum of fibre plants in connection with the Forests Products Laboratory at McGill University, Montreal. There were several other inquiries about flax and requests for samples. One was from a firm in England through their Montreal agents, who wished to test samples of Canadian-grown flax straw, and who stated that, if found suitable for the purpose, they could use very large quantities of it. Two bales, each weighing about 110 pounds, of flax straw grown at Indian Head, Sask., and on the Central Experimental Farm at Ottawa were sent forward, but no report on the quality of the sample has yet been received. There was also a request from a firm in Ireland for samples of both Canadian-grown flax seed and flax straw, both of which were sent. Samples of flax and flax fibre were also

exhibited at the Central Canada Exhibition at Ottawa. Other particulars regarding experiments with flax carried out at the Central Experimental Farm will be found in a separate section below.

The usual work in connection with the Arboretum and Botanical Garden was carried out during the year, and several additional plots were laid out for experiments and observations on weeds and other wild plants, the herbaceous border being kept for more showy species.

An exchange list of seeds of 370 species was sent out to twenty-six of the principal Botanic Gardens of the world, and packets of seeds were sent to the following Botanical Gardens: 27 to Aulnay sur Bois, France; 7 to Trinity College, Dublin, Ireland; 44 to Oxford, England; 6 to New York; 7 to Glasnevin, Dublin, Ireland; 11 to St. Louis, Missouri; 21 to Nancy, France; 17 to Lausanne, Switzerland; 9 to Groningen, Holland; 18 to Lund, Sweden; 2 to East Lansing, Michigan; 36 to Upsala, Sweden.

In return considerable numbers of species were received as follows: 20 from Washington, D. C.; 10 from Brooklyn, N.Y.; 13 from Trinity College, Dublin; 29 from Glasnevin, Ireland; 1 from Ekaterinburg, Russia; 10 from Tiflis, Caucasia; 33 from Nancy, France; 27 from Lausanne, Switzerland. In addition a rooted specimen of *Larix dahurica* Turcz, was received from the Bureau of Plant Industry, Washington, D.C.

During the year Exhibition Circular No. 77 on the "Cultivation of Flax for Fibre" was published, and an illustrated Bulletin No. 28, second series, on "Flax for Fibre, its Cultivation and Handling," was prepared.

Experiments with Hemp.—A small plot measuring 1/269 of an acre in extent was sown on May 12, 1915, with seed obtained from the Bureau of Plant Industry, Washington, D.C. It was sown at the rate of 33 pounds per acre. On August 30 the average height of the crop was 5 feet, the tallest being 6½ feet. The early part of the season had been dry and this doubtless affected the growth to a considerable extent. It was pulled on August 30, when the pollen was being shed, and retted by floating on the surface of water. It was sent after drying to the Doon Twine Mills, Ontario, for report. The reply received was as follows:—

"The fibre in this hemp seems to be of very good quality, but we think it has been pretty badly spoiled in the retting. It is not extra long hemp but the quality of the fibre is better than if it had been long. We could use any amount of this class of straw properly retted. We think in southern Ontario it would grow a great deal better than on your Farm in Ottawa."

Some of the same sample of seed was sown on May 31, 1915, to see whether it would be possible to ripen the seeds in this latitude. Several plants in which the first seeds were ripe were cut between October 22 and 29 and allowed to dry. The last plants were cut on November 11, and when threshed yielded a considerable number of well-ripened seeds. When cleaned and tested they gave a germination of 90 per cent. The crop successfully withstood a temperature of 25 degrees F. on October 25.

Experiments with Flax.—During the year 1915 several plots of flax for fibre were grown at the Central Experimental Farm. Two brands of seed were used, namely, Dutch-Riga-Child, imported direct from Holland, by special arrangement between the Dominion Botanist and Dr. Ritzema-Bos, and Canadian-grown seed purchased in Ottawa. The Dutch seed when tested gave a germination of 73·5 per cent and the Canadian seed a germination of 100 per cent. The plots sown were of two sizes, namely, one-fortieth acre and one-eightieth acre, and the seed was sown on various dates between the 10th and 25th of May. The rate of sowing varied between 1¼ and 3 bushels per acre. The average height of four plots grown from Dutch seed was 28½ inches, and the average height of five plots from Canadian seed was 21½ inches. The plots were pulled for the most part at three dif-

ferent stages of ripeness; in some cases the capsules were fully formed but none of the seeds were ripe; in others the first capsule on each plant was ripe while in the third series about half the capsules were ripe. The latest-sown plot became badly affected with flax-rust. Some plots were stooked to dry and the capsules were removed subsequently by rippling; in other cases the capsules were removed and the flax was retted directly, the capsules being spread on a cloth and allowed to dry. The capsules in both cases were subsequently crushed and the seeds separated and cleaned. An estimate of the quantity of seed was made in the case of four plots of Dutch flax and these yielded 6, 5, 4½, and 7¼ bushels per acre, 56 pounds being taken to the bushel.

After pulling, the flax was retted in water. For this purpose four ponds, each about 3 feet deep were dug in a corner of the Botanical Garden near the Rideau canal, and filled with water. This water, on analysis by Dr. Shutt, gave 9·03 degrees of hardness on Clark's scale. It was found that there was a difference of 12° F. between the temperature of the water at the bottom and that at the surface on warm days, and in consequence of this difference, the bundles of flax were floated on the surface and kept under water by the aid of planks weighted with stones (Plate LIX). In order to ret uniformly, the water surrounding the bundle should all be approximately at the same temperature. The surface temperature on certain days rose as high as 80° F.; later in the season, when other samples of flax not grown on the Central Experimental Farm were being retted, the temperature was as low as 47° F., a figure which is not calculated to give satisfactory results. The time taken for retting varied with the season of the year. During warm weather some samples were taken out after 2¾ days' immersion, while later on when the weather was becoming colder nine days were required.

It was found that some of the samples were a little under-retted. The time taken for retting appeared to vary somewhat with the age of the flax when pulled, the subsequent drying of the flax before retting, the thickness of the flax stems, which again depends on the rate of seeding, the temperature and the hardness of the water employed, and the degree of tightness of the bundles. If the flax bundle is tied tightly the central part rets more slowly than the outside and presumably a large bundle would require longer time for retting than a small bundle.

The tanks used for retting were pumped out several times during the season and filled again with clean water.

It is not advisable to ret flax after the middle of September in this climate if the best results are to be obtained.

After being taken from the dam the flax was spread in thin layers on the grass to dry (Plate LX foreground). The spreading on the grass has the effect of carrying on somewhat further the process of retting and at the same time improves the colour. The time that flax should be allowed to remain on the grass must be largely determined by the condition of the flax and by the nature of the weather. If it is slightly under-retted when taken from the water the effect of "grassing" will be to complete the retting process. If the weather is showery over-retting may result, or it may be difficult to get it properly dried. Sometimes it is necessary to set the flax straw up on end to get it dried, the process being known as "wigwaming" or "steepling" (Plate LX).

The time occupied on the grass by different samples varied between one and seventeen days. When properly dried, the retted straw was kept under cover and was afterwards sent to the scutch mill to be reported on. Some samples were scutched at Forest, Ont., but the greater number were sent to the mill of the Ontario Flax Co., Ltd., Parkhill, Ont. The manager of this mill, who represents the York St. Flax Spinning Co., of Belfast, Ireland, and who has a large experience in handling flax fibre, kindly reported on the comparative value of the samples submitted to him. For this purpose he divided them into the following six classes:—

No. I. This is a well grown flax, with sound fibre suitable for warp spinning. Would compare favourably with Irish flax.

No. II. Not as long a flax as No. 1, but as suitable in every other way.

No. III. Strong hard flax not as well retted as first two numbers.

No. IV. Short, scrubby, under-retted.

No. V. Short, poor fibre, under-retted.

No. VI. Short, with no value for fibre.

Of the samples grown on the Central Experimental Farm none were placed in class I. One grown from Dutch seed was placed in class II. Three from Dutch seed and two grown from Canadian seed were placed in class III, and three grown from Canadian seed were placed in class IV.

In addition to the samples of flax grown on the Central Experimental Farm, various others from different parts of Canada were retted and afterwards scutched at Parkhill. Fourteen were received from the following places in southwestern Ontario: Floradale, Conestogo, Dashwood, Zurich, Exeter, Wingham, Ripley, Hensall, Crediton, Forest, Parkhill, Oilsprings. These were grown chiefly for their fibre, some being Blue Blossom and others White Blossom varieties. The seed was obtained originally from Holland, Belgium or Russia. The samples varied in length from 2 to 3 feet and in most of them the bulk of the seeds was ripe. Of these samples eight were placed in class I, four in class II, and two in class III.

In addition to the foregoing, fifty-four samples were sent in by the Superintendents of the Branch Farms. One of these was from Lacombe, Alta.; 9 from Lethbridge, Alta.; 3 from Rosthern, Sask.; 17 from Indian Head, Sask.; 10 from Scott, Sask.; 9 from Morden, Man.; 4 from Brandon, Man., and 1 from Ground Hog River Experimental Farm in northern Ontario. Nine of the samples from Indian Head were grown expressly for fibre, being sown on different dates and on different classes of land. The others appeared to have been sown for seed-production only. One sample had been cut while all the others were pulled. The length of the pulled samples varied between 11½ and 36 inches. As is usual in flax grown for seed, the stems, in a large number of cases, were branched near the base.

After scutching, these samples were classed as follows: Class I, none; class II, 2; class III, 15; class IV, 16; class V, 14; class VI, 7. The two best samples were grown at Lethbridge.

Sixteen samples belonging to two varieties, Novelty and Longstem, were retted for Dr. C. E. Saunders, Dominion Cerealist. These were grown on the Experimental Farms at the following places: Fredericton, N.B., Ste. Anne de la Pocatière, Que., Cap Rouge, Que., Indian Head, Sask., Rosthern, Sask., Lacombe, Alta., Lethbridge, Alta., Agassiz, B.C. The variety Novelty varied in length between 18 and 30 inches, and Longstem between 24 and 41 inches. These were also scutched at Parkhill and were valued as follows: 2 in class I, 3 in class III, 5 in class IV, 3 in class V, 3 in class VI. The two best samples were both grown at Agassiz, B.C.

Some miscellaneous observations were made, during the year, the more important of which are given below:—

A plot of flax was left growing in order to see whether it was possible to ripen all the seeds. The latter part of the season was very wet and as a result of this it was found that as late as the 1st of October there were still some plants bearing some green unripe capsules.

In order to determine whether flax flowers are self-pollinated, five unopened flowers were enclosed in fine meshwork bags. The weather was very wet for some time afterwards but yet three of the flowers developed full-sized capsules. The pollen grains when placed in water swell up and burst. It would therefore appear that a period of rainy weather is unfavourable to the formation of seeds and that it should be comparatively easy to keep a particular variety pure.

Ottawa.

A plot of flax grown from Canadian seed was pulled when the first capsule on each plant was ripe. This when reported on at Parkhill was valued as class III. Some more flax from the same plot was pulled twenty-four days later, when about nine-tenths of the capsules were ripe and this was valued as class V.

Seeds obtained from a crop of flax in which only some of the capsules were ripe at the time of pulling were weighed and compared with those taken from a crop with seeds better ripened. In the former case 100 seeds weighed 387 milligrams, while in the latter 100 seeds weighed 425 milligrams. A milligram is equal to $\frac{1}{453603}$ of a pound. The seed in both cases was the same and was Dutch-Riga-Child. It is scarcely possible at present to say whether large or medium-sized seeds will give the better quality of fibre but it seems probable that the seeds from a fully ripened crop would germinate more uniformly when sown and presumably would give a more uniform crop.

For the purpose of finding out what change, if any, took place in the fibres as they grew older, sections were made of younger and older stems and microchemical tests were applied. Both aniline hydrochloride and phloroglucin showed that even in comparatively young stems a certain amount of lignification took place and, as might have been expected, this was rather more pronounced in the older stems. It is not possible to say yet whether there are any varieties of flax in which no lignification of the fibres occurs but if there are it would seem desirable to select such varieties for the best class of fibre.

In order to determine the percentage of fibre to retted straw more accurately than by the ordinary commercial methods of scutching small samples of retted flax from different localities were weighed on a chemical balance and the fibre obtained by scutching them between the fingers was determined in the same way. The samples of flax tested in this way were as follows:—

PB Seed of Canadian origin. Plot grown on Central Experimental Farm, Ottawa.

PC Same as PB.

IH_1 Seed of Canadian origin. Crop grown at Indian Head, Sask.

C Seed imported from Holland. Crop grown at Ottawa.

IH^2 Same as IH_1.

OF^2 Seed grown in Canada. Crop grown at Conestogo, Ont.

EF_{13} Seed of Canadian origin. Crop grown at Lethbridge, Alta.

S_{11} Seed grown in Canada. Crop grown at Agassiz, B.C.

Five thick and five slender stalks were taken from the same bundle in each case and the average diameter of each stalk half way up was measured. In the case of PB, PC, IH_1 and C the roots and branching tops were included while in IH_2, OF_2, EF_{13}, and S_{11} the roots and branches were cut off before weighing.

—	Thick stems, average diameter in millimetres.	Per cent of fibre.	Thin stems, average diameter in millimetres.	Per cent of fibre.
PB	2·1	18·24	1·1	23·75
PC	1·8	20·25	1·1	26·23
IH_1	1·8	19·64	1·1	19·23
C	2·4	24·63	1·8	26·38
IH_2	1·7	23·67	1·0	27·45
OF_2	2·2	28·14	1·4	33·33
EF_{13}	2·9	22·96	1·9	29·20
S_{11}	2·2	26·03	1·6	28·34
Average	2·1	22·94	1·4	26·74

A millimetre is equal to about one twenty-fifth of an inch.

From a study of the above figures the inference seems reasonable that a fairly thick rate of seeding which will produce more slender stems, will give a larger amount of fibre per acre than a thinner rate of seeding which will produce fewer but thicker stems. This is on the assumption that the crop in both cases attains the same height.

It appears to be somewhat generally believed that early sowing of flax is not desirable owing to the danger of its being killed by frost. There is, however no foundation for this belief. After the flax was pulled considerable numbers of seeds were scattered in some plots and large numbers of seedlings resulted. Almost every stage of development was represented from plants an inch high or less with cotyledons to specimens a foot high. On the 25th of October, 1915, the temperature fell to 25° F. in the shade, but no injury resulted. On the 17th of November a shade temperature of 17° F. was reached and still the flax plants survived. On the 20th November the temperature fell to 14° F., after which some plants 9 inches high were still green. It may therefore be assumed that flax can safely be sown in spring as soon as the ground can be got into proper working order.

Wild Rice (Plate LXI).—Every year we keep receiving inquiries concerning the sources of supply in Canada of germinable wild rice. Correspondents nearly always relate that any attempt to grow purchased seed resulted in failure. Government fish hatcheries also applied for information on the growing of wild rice. It is evident from the inquiries received that the wild rice is intended to serve the purpose of protection and food for fish and fowl. Wild rice is an annual plant which produces a large hard seed about ¾ of an inch long and 1/16 inch broad. This seed is collected by the Indians, and no doubt by the white population who have discovered its culinary uses and become accustomed to it; it is generally roasted on hot stones, broken up and prepared by cooking it like Chinese rice or by using it in the same way as oatmeal porridge. It tastes decidedly grassy, which taste is much removed by soaking the wild rice over night in water and changing same for slightly salted water for cooking.

The difficulty has always been to get this plant established where it does not grow wild. The seed is difficult to obtain viable. All the samples procured from dealers, that we have tested, were found to be dead. We therefore tried experiments for a number of years relating to the storing of wild rice seed over winter in such a manner that it

would retain its life. This result has now been very satisfactorily attained. The rice seed is harvested, emptied into a bag partly immersed in water and is kept in a barrel filled with water until about November, it is then placed in a box and buried outside in the ground, not necessarily near a pond or river, but almost any convenient place. Freezing solid of the whole bulk does not affect the germinating power so long as the seed is covered by about 6 inches of soil. In spring the seed gave nearly 100 per cent germination.

It should either be sown directly after harvest, by scattering it close to the banks of ponds or rivers where it is wanted, or early in spring when seed may be shipped mixed with damp moss. Wild rice does not grow in swift waters, nor where there is no soil bottom, as in glacial streams, for instance. The young plants should be protected the first year from rats and birds, or the seeds will all be eaten off before they are ripe; and, being an annual plant, it will not come up again next year unless new seed is sown. It produces an abundance of seed, and will be quite permanent once it is afforded a fair chance.

IV. REPORT FROM THE FIELD LABORATORY OF PLANT PATHOLOGY, ST. CATHARINES, ONT.

(W. A. McCubbin, M.A., *Assistant in Charge.*)

In addition to the experiments and surveys carried on during the year in connection with various diseases, of which the White Pine Blister Rust may be noted as receiving a large amount of attention (*vide* section I, Destructive Insect and Pest Act), a few other features of the work deserve mention.

During the winter months a series of twelve addresses illustrated by lantern slides was given to agricultural classes throughout the province on the subject of plant diseases, and some eight other addresses on various disease topics were also delivered at various times throughout the year.

The inspection at Niagara Falls of seed potatoes imported from the United States occupied a great deal of time in the spring months, and both field and crop inspections of potatoes were made during the year for various members of the Canadian Seed Growers' Association.

Inquiries for information on diseases are yearly increasing in number, and are becoming a prominent feature of the work of this laboratory.

General Conditions in 1915.—The winter of 1914-15 was very favourable from the standpoint of the fruit-grower, and few cases of winter injury occurred throughout the Niagara district. The spring opened up somewhat earlier than usual and the cold period which followed in April and May retarded the early planting of many crops, especially of tomatoes. On May 27 there was a severe frost which greatly damaged many of the early crops in the province, and which was particularly severe on the early tomatoes. Injury from this late frost was comparatively light in the Niagara region, but elsewhere considerable damage was done.

The summer was generally characterized by an excessive amount of rainfall, and the frequent showers which came at short intervals kept the soil much too full of water until September. Owing to the abnormally wet conditions, several diseases became epidemic, among which the Late Blight of potatoes deserves first mention, as it was almost universal in Ontario, and very disastrous in some localities. Brown Rot of stone fruits, Leaf Spot of plum and cherries, and Apple Scab, were also more prevalent than usual. In addition, a large number of plants of various kinds either died or were badly injured because of the rotting of their rootlets in the water-logged soil. Potatoes, tomatoes, and beans suffered heavily in this way, but the same sort of injury was not infrequent in fruit trees, particularly in cherries.

Drier weather conditions prevailed during the autumn months, and this, in conjunction with a long and gradual fall in the temperature to winter conditions, sent the tender fruits into the dormant state under very favourable circumstances.

Squirrel-Scars on Maple Limbs.—The limbs of the sugar maple (*Acer saccharum* Marsh.), have many times been noted by the writer to be covered with scars, particularly on their upper surfaces. The injury is most common on the lower branches, especially if these project more or less horizontally from the trunk, and is usually to be seen in trees growing along fences or on the edges of woods. On such trees, limbs may often be seen which have the whole of their upper surfaces covered with innumerable lumpy distorted swellings, as if countless wounds had been made in them from above. The individual wounds which bring about this appearance are evidently made at different times, since they show various stages of the healing process. Some are entirely healed over, while others are of very recent origin. All of them, however, show a characteristic darkening of the wood below the point of injury, thus indicating that the cambium must have been affected by the wounding. These discoloured areas are not extensive either in surface or depth, and there is often a bluish-green tinge associated with the normally very dark appearance of the tissue. In a number of cases where the wounds still remained open, a small fungus, apparently belonging to the genus *Ceratostoma,* was present on the exposed wood, and it is perhaps the action of this fungus on the tissue before the wound has healed over that brings about the peculiar discoloration noted.

The actual cause of these wounds was somewhat of a puzzle to the writer until in April, 1915, several trees were seen which bore unmistakeable evidence of the fact that such injuries are due to the bites of the common red squirrel. In trying to find as recent a wound as possible, it was noted that, in the earlier stages, the scars left were always in pairs, which naturally suggested the work of some animal. After a search a tree was found on which the actual teeth marks only a few days old were to be seen, and it may be noted that these were all on limbs which bore already the scars of many such injuries in previous years. A close examination of these marks was made, and from the nature of the wound, its size, depth and position, there could be no doubt that it was due to the animal in question, probably in an endeavour to obtain sap. This tree was examined on April 21, and the injury probably took place about the 18th, at the time when the maple sap was still running freely, so that it is reasonable to suppose that the squirrel was after sap.

In making the wound the teeth are sunk deeply into the limb, sometimes so far that they gouge a piece from the wood or break the bark away from the cambium. The piece so loosened dies, and an open wound is left. In other cases only the upper teeth are deeply sunk, the lower ones merely injuring the cortex, leaving a small superficial cicatrix. After a year's growth this cicatrix is almost lost sight of in the roughened swelling arising from the wound made by the upper teeth, and the third year it disappears altogether.

Defoliation of Sycamore.—In a former report (1914-15) the fungus *Gloeosporium nervisequum* (Fckl.) Sacc. was noted as damaging the leaves of oak trees. During the recent spring the same, or a very similar fungus, was responsible for the defoliation of large numbers of our native sycamore or buttonwood (*Platanus occidentalis* L.) The injury took place when the leaves were unfolding, and was so severe in many cases that not only was every leaf on the tree destroyed, but a great many twigs were killed as well. Such trees later on put out new leaves and seemed to suffer very little further damage throughout the rest of the summer. It is to be noted that the second set of leaves was somewhat smaller than normal, and also fewer in number, but otherwise the trees remained perfectly healthy and vigorous all year.

In leaves which have been killed in this way there can usually be seen rows of little black spore pustules (*pycnidia*) set closely along the midrib and veins. Similar

minute spore pustules are to be found on the twigs, which are killed by it, but in this case they are scattered irregularly over the surface.

There is no record of the prevalence of this disease in former years, but, judging from the destruction of the terminal growth of limbs during the present year, its frequent recurrence would, perhaps, partially account for the ragged, crooked growth of many of our sycamore trees. It is noteworthy, also, that there was a possibility of initial injury of these leaves and twigs by the late frost of May 27, which might have rendered them especially susceptible to the attacks of the fungus.

A cherry fruit spot due to frost.—During the sour-cherry season a number of cherries were noted in various places in which small, brown, dead spots were present in the flesh. No fungus could be obtained by cultures from these spots, and they did not increase in size in storage. It is thought that they are a rather unusual result of the late spring frost of May 27. Many plums and cherries were killed outright by this frost throughout the province, and many others were so injured that irregular, one-sided development resulted. Several of the latter were found on the trees which bore the spotted fruit, as well as other stages intermediate between this more pronounced injury and the spots in question. As these spotted fruits were all found on trees in the Niagara peninsula, where the frost was comparatively light, it is not impossible that small areas of tissue might have been destroyed in these fruits without causing enough injury to prevent subsequent development; so that the mature fruit was normal in every way except for small islands of brown tissue in the flesh.

Cherry: Injury due to wet soil.—During the month of August a large number of young sweet and sour cherry trees (especially the latter) died out, under conditions that strongly suggest root trouble of some kind. Either the whole top suddenly wilted and died, with the leaves remaining on the trees, or else there was a marked casting of the leaves extending over a considerable period. In some cases the leaf fall was directly traceable to the work of the Shot-hole fungus, which was exceedingly plentiful this year, but in a number of others there was not enough of the fungus present to account for the excessive dropping of the foliage. There is good reason to think that these defoliated trees have all suffered more or less from the same cause which has been responsible for the death of those which have wilted suddenly, viz., wet soil. Numbers of trees in both conditions have been examined, and it is found that they all exhibit the same symptom, though in varying degrees. When the roots of such trees are dug up the larger roots are seen to have a water-soaked appearance, while the smaller roots and rootlets are quite brown and completely rotted. The trunks on the other hand are much drier than normal and are often discoloured.

In the case of the trees which die suddenly there is no doubt that the excess of water in the soil is the factor concerned. The rotting away of the innumerable little rootlets greatly reduces the water-absorbing power of the root, for it must be remembered that the larger roots are covered with a thick and corky bark through which water can scarcely pass. It would perhaps be fair to say that by the loss of these rootlets the power of the plant to absorb water drops to a quarter of what it ought to be. Aside from this lack of absorbing power there is also another factor in cases of wet feet that hastens the death of the tree. The rotting of the roots produces certain substances which, when carried up in the sap, poison the tissues and clog the sap-conducting tubes in the stem, so that even the small amount of water that is absorbed moves up to the top with great difficulty. In such cases, therefore, the top of the tree is suffering from lack of water although there is plenty of it in the soil.

The wilting of the leaves in extreme cases is very good evidence that the state of affairs outlined above actually exists in the roots. In the milder cases, where the roots are only partially destroyed, sufficient water passes up the stem to prevent

wilting, but not enough for the normal needs of the plant, so that the top lives in a state of drought. The casting of leaves is always a symptom strongly suspicious of drought conditions, when there is no other factor to account for it, so that it is only reasonable to think that unfavourable root conditions may be partially responsible for the excessive leaf-fall of these cherry trees. There is no doubt that the Shot-hole fungus can attack the leaves on a weakened tree much more readily than on a healthy one, and this may also help to explain the prevalence of this disease during the present season.

Winter-killing of Strawberry Roots.—A considerable amount of loss was caused to strawberry growers during the year just ended by what has been popularly called "Root Rot," but which was really a killing of the roots by heavy frosts in spring after the early mild weather had started the plants to grow. Very few of the affected plants showed any signs of the injury at the time. While the spring moisture was plentiful, they leafed out well and set fruit abundantly, but later on, when drier conditions followed, they began to shrivel up and die. The weakest and worst injured plants died before ripening any fruit, but the greatest number lived on till midsummer and then dropped off all through the picking season. Many others, which were only slightly affected, recovered, but too late to save their fruit, which was undersized and scanty. Although there was no scarcity of moisture throughout the summer, the appearance of some of these fields at picking time strongly suggested the effects of a severe drought. The earlier-formed leaves were mostly dead and the later ones were small and their tips and edges were badly sunburned.

When the roots of such plants were examined, it was found that they were brown, shrivelled and more or less brittle and rotten. In some cases, the characteristic brown discoloration extended into the crown, especially if it was set low in the earth. It should be noted here that browning of the roots externally is quite a normal condition for the strawberry as well as for other plants. When the root is first formed it is white and glistening on the outside; at the end of the first year, however, the outer part browns and dies, but there is left within a small core of white, living tissue. When such a root is pulled apart lengthwise, this centre comes out as a small, white cord. In the frozen roots this core is quite brown, and in later stages it becomes so brittle that the roots will not stand pulling from the ground. Any determination of root killing should, therefore, be based, not on the brown outward appearance, but on the condition of the living central part.

Although this injury reduced a great many crops from a quarter to a third below their normal yield, it is encouraging to note that, towards the end of the summer, most of these fields recovered to a great extent. Runners filled in the gaps and the slightly injured plants started into vigorous growth again so that by fall the fields presented almost a normal appearance.

It should be mentioned that, in some cases, additional loss resulted from the use of sets from these fields. Although it was not noticed at the time they were transplanted, their roots were also injured, and the newly-set field was a failure. It would be wise when planting out a field in spring to take the precaution of looking at enough of the roots of the sets to make sure that they are still sound. The differences pointed out above between healthy and frozen roots will enable any one to do this readily.

Strawberry Mildew (Sphærotheca humuli DC..)—The unusually wet weather of the early part of the summer induced a very severe attack of this fungus on strawberry leaves. It is a well-known fungus but it is only occasionally abundant enough to be important, the last epidemic in this district having occurred in 1908.

The fungus appears mainly on the under sides of the leaves where it may be seen as a white, downy coating. When it is present in quantity in a field, the leaves become

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perceptibly lighter in colour and curl up at the edges. In most cases, the action of the sunlight on the upturned under surfaces turns the normal colour into a pronounced reddish or purplish tint, quite noticeable in looking over the field even from a distance. Later on, many of the edges and tips of the leaves die, which makes the whole field look unhealthy. The curling up of the leaves is decidedly bad for the crop as it uncovers the young fruit to the sun. Such fruit, instead of developing as it normally should, under the shady moisture of a thick layer of leaves, is exposed to the dryness and heat, and a crop of poor, small fruit is all that ripens.

With the advent of dry and hot weather, the epidemic of this mildew suddenly ceased, but, in many cases, the after effects noted above followed in due course, although nearly all traces of the fungus itself soon disappeared.

From experiments carried on by Mr. F. M. Clement, of the Vineland Horticultural Experiment Station, ordinary sulphur dusted along the rows seemed to have a beneficial effect though the applications were made too near the end of the epidemic to give any striking difference between the dusted and the untreated rows.

A ripe rot of fruits due to Rhizopus nigricans Ehr.—This fungus has been frequently met with on fallen peaches and pears in the orchard, and occasionally in basketed fruit. In order to determine whether it was actually the cause of the rot in these cases or was only of secondary importance, several inoculations were made with a pure culture of the fungus. In every case a deep and rapid rot followed. In pears, the spot produced had a water-soaked appearance outwardly and the tissue within was soft and wet, but not deeply discoloured. In peaches, the spot soon became very black, and the rotted tissue within became very tough from the matting of the hyphal threads.

It is only when ripe that these fruits seem to be susceptible to the attacks of the "Bread Mould" fungus. No rot due to it has ever been met with in green or incompletely ripened fruits.

Heart rot of peach trees.—A considerable percentage of peach trees break down each year during the fruit season because of mechanical weaknesses in the trunk and main limbs. In some cases the weakness is due solely to what might be termed crotch splitting. As every peach grower knows, the peach is peculiarly subject to this splitting, especially if the main limbs are allowed to grow in a narrow rather than a wide "V." Far greater mechanical strength is secured in the tree when the main limbs are trained in early life to start out as nearly at right angles to the trunk as possible. To some extent this is a matter of variety, but a great deal can be done in the first few years of growth if pruning operations take into consideration the attainment of mechanical strength in the adult tree.

This weakening of the tree by a split in the crotch is in itself sufficiently serious to be worth attention in the young orchard, but such weaknesses are, in a great majority of cases, increased many fold by the action of fungi which gain entrance through the split and cause a rot of the heart wood within. Very few crotch splits remain free from these fungi for any length of time after they are formed. They can be seen in almost any broken-down limb at the crotch as bits of white felt-like growth on the surface or in the tissue of the wood. The effect of such fungi on the wood can also be readily determined by any one. Ordinary heart wood has usually a clear light-brown colour and is firm and tough. When such wood has been acted on by these fungi, however, it becomes pallid in colour and very soft and brittle in texture. In other words, it ceases to be of any use in supporting the branch and the whole duty of support falls on the thin outer layer of newly-formed wood. In the limbs in which the heart wood is rotted in this way, it can be seen that the supporting strength depends on a thin cylinder of the outer wood, or if put in another way, the limb, as far as its actual strength is concerned, is merely a tube filled with a pithy and useless centre. Now a tube is a very strong mechanical structure, and, as far as the limbs are

concerned, this arrangement seems to be usually adequate, so that round and uninjured limbs rarely break even if rotted at the heart. Where such a branch joins the trunk with a split crotch, on the other hand, all the strength due to the tubular arrangement of the sound wood is lost, for at this point the sound wood consists of a flat band on the lower side of the limb,—a band easily broken by a little extra weight. After a split crotch has been attacked by fungi it is only a matter of time before one of the limbs, or both, will break down from the weakness caused by the rotting of the heart wood at this joint.

Just how long a time is required for this weakening process depends on various things, but from one to three years would probably be a fair estimate.

While the breaking off of branches is the most important phase of the injury caused by these heart rot fungi, a considerable amount of damage results from them in other ways. When infection is plentiful from spores produced on the "shelf fungi" arising from dead parts about the tree, these fungi are apt to infest a great many of the pruning wounds, and may often make their way from these wounds to the heart wood of branches. Cultures recently made from two peach branches adjoining pruned stubs demonstrated that the particular shelf fungus in this case had penetrated into the heart for a distance of about 30 inches. The two branches were three and four years of age at the base, and the fungus had, at the time of examination, reached the base of the last year's growth. Outwardly these branches were healthy, though of somewhat shorter growth than usual. In numbers of orchards, nearly every tree is suffering to some extent from heart rot of this kind, and while the trees may not die outright from the attack, their vitality is lowered and the wood rendered so brittle that branch after branch breaks off at the weak places leaving a mere fragment of what the tree ought to be.

The heart rot in question is apparently due to a number of species of the Polypores, or as they are more popularly called, "Shelf Fungi." It is quite probable that all of these are native with us and could be found in our woods growing on other trees, many of which suffer from heart rots also. These shelf fungi grow as well on dead wood of many kinds, and it is possible that they are only able to attack those parts of our peach trees which are dead, dying, or greatly weakened in some way. There is reason to think that winter injury may make a tree liable to their attack.

It need hardly be said that spraying will have little or no effect in checking heart rot. The fungi causing it live inside the tissues where no spray can reach, and although the "shelves" from which the spores are spread are comparatively few in number, yet each one produces innumerable spores which it sheds continuously for several weeks, so that infection takes place more readily than one would at first think.

It has been suggested elsewhere (Report of Dominion Botanist, 1914-15) that a hopeful means in dealing with peach canker involves careful attention to pruning methods, especially in removing from the tree all dead and dying wood. There is no doubt that the heart rot can be reduced in a similar way, for if all the sources of infection in old dead limbs, tree trunks, pruning stubs, etc., are taken out, the fungi causing the rot will have no place to gain entrance to the trees, and, what is still more important, they will have no chance to spread from to tree. In view of the constant and increasing losses from these wood-destroying fungi, it is probable that a great deal more attention will have to be given in future to the question of cleanliness in pruning than has been the custom in the past.

Purple spotting of Raspberry canes.—This trouble is of frequent occurrence on the canes of the red raspberry, and it has been the subject of many inquiries during the last two years.

The spotting is usually noticed first some time after the middle of the summer, often about the time the old canes are being removed. The new canes are then observed to have a number of purple or reddish-brown spots of varying sizes here and there along

them, but especially on the lower half of the stem. A few minutes' examination will convince one that these spots nearly always arise from around the bases of old dead leaf-stalks, and, if enough spots are examined, all stages in their development can be made out, from the tiny spot around the stalk to the stages where the affected area has become so large that practically all of the stem is covered. In advanced cases the spots arising from the various centres meet each other so that the whole stem for a considerable distance is discoloured. The colour in the early stages is, as already noted, purplish, or purplish-brown, but as time goes on it changes to brownish-grey, owing to the dying of the thin outer skin. Later in the fall or during the next spring the affected parts assume a silvery hue, and, if one looks closely, there may be seen in the whitish areas a number of very minute black specks.

This purple discoloration is due to the work of a small fungus (*Sphaerella rubina* Stewart and Eustace), which comes into the stem by way of the old dead leaf-stalks, and then spreads slowly over the adjoining area just under the thin outer skin. Apparently it does not go very far into the tissues, for if one scratches the surface, normal, green, healthy tissue is always present underneath. That the damage done by this fungus is of a quite superficial nature is also shown by a microscopic study of the stem tissue under these spots. The thin skin already mentioned, which serves as a protection to the plant in the young stages, is replaced at the end of the first year by a somewhat thicker growth of corky material, which arises just underneath the outer skin. The thin outer skin is afterwards partially shed, and may often be seen hanging loosely about the lower parts of the stalks during the second year. When thin sections of the stem are cut through the discoloured areas, it is readily seen that the region affected by the fungus lies entirely outside of the protective layer, and that the formation of this layer has not been interfered with, except that it commences to form a little sooner than in the normal canes. It should also be noted that the buds which have been produced in the axils of the old dead leaf-stalks, and which are in the middle of the affected area, are usually quite sound and green within.

From the above considerations it is apparent that the actual damage done by this fungus on the canes is so small that no anxiety need be caused by its presence. Experience shows that canes that might have been badly affected by the spotting during the first year, are quite healthy and vigorous the year after, and while there may be isolated cases where canes are girdled or buds destroyed, such cases are too few to be of any importance.

The small black pimples with which the silvered areas are studded during the spring of the second year are the spore-bearing organs of the fungus, and from them the spores spread in early summer to the young growth. Since these spores are produced on vigorous canes which are about to fruit, the cutting out and burning of canes, which is such a useful means of keeping the raspberry field free from a number of other troubles, would not help in this case, for the diseased canes could not be removed till after the crop had been taken off, long after the infection had passed on to the new growth. Neither would spraying be likely to control the disease satisfactorily, since the fungus lives under the bark and from this protected position sends its spores to the new growth for a considerable part of the summer. Only a series of sprayings to protect the young growth during this period of spore production would insure freedom from infection, and it is doubtful if even this method would give adequate protection.

It is rather fortunate that the injury done by this fungus is of a comparatively trivial nature, for if it was so damaging that control measures would become necessary, as in the case of Raspberry Cane Blight, it might give a great deal of trouble.

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Mosaic Disease of Tomato.—In the report of the Dominion Botanist for 1914-15 a few observations on this disease were recorded, and an approximate estimate of the prevalence of the disease was made, according to which fifteen fields were found to be affected out of sixty-one examined—about 26 per cent.

Later on, it was seen that a more accurate result would be obtained by estimating the percentage of mosaic plants without reference to the fields, which vary so much in size that the mere tabulation of the presence or absence of the disease is of little help in estimating the amount of mosaic present generally throughout the whole district. Accordingly, a survey of some 26 fields was made in 1915 in order to obtain data for computing the general prevalence of the disease. The results are given in table form below:—

Number.	Date.	Plants examined.	Plants diseased.	Percentage of disease.
1	July 13	220	2	0·96
2	" 14	200	0	0·00
3	" 14	53	0	0·00
4	" 14	200	0	0·00
5	Aug. 2	300	1	0·33
6	" 2	200	0	0·00
7	" 2	600	0	0·00
8	" 2	400	6	1·50
9	" 2	400	1	0·25
10	" 2	400	0	0·00
11	" 2	200	54	27·00
12	" 6	400	1	0·25
13	" 6	500	0	0·00
14	" 6	400	0	0·00
15	" 6	500	1	0·20
16	" 6	600	0	0·00
17	" 6	400	11	2·75
18	" 9	400	0	0·00
19	" 9	160	0	0·00
20	" 9	280	0	0·00
21	" 9	90	50	55·55
22	" 9	180	1	0·55
23	" 9	200	0	0·00
24	" 10	600	0	0·00
25	" 10	200	0	0·00
26	" 10	500	0	0·00
Totals		8,583	128	

	Per cent.
Percentage of fields affected	40
Actual percentage of diseased plants found	1·49
Average percentage of all the fields	3·43
Average of all but two worst fields	0·28

In the above table it will be noted that two of the fields showed an amount of disease far in excess of any of the others. The wide gap which separates these two from the rest—a gap unfilled by intermediate stages—suggests the existence of an additional causal factor in these cases. It is almost certain that this factor is seed bed infection. In No. 11, where 27 per cent of the field was affected, the plants were started in greenhouse flats and later transplanted to a cold frame. The earth in this cold frame was the same as that used for the previous year, with the addition of fresh material, so that there was ample opportunity for infection to be carried over in the soil. While no information is available regarding the early stages of the plants in No.

21, where 55·55 per cent of infection occurred, yet it is very likely that the grower, who raised large numbers of plants for sale, also followed the usual practice of using the earth left over from the preceding year.

As pointed out in the notes previously written (Report Dominion Botanist, 1914-15), there is often present in connection with this disease a strong indication of seed-bed infection: the occurrence of the diseased plants definitely in rows or parts of rows. It is hard to explain why the disease should occur in this way if its presence is due to field or soil infection. In field infection especially, which has been attributed to the successive contacts of cultivating implements, etc., with diseased and healthy plants, one could not look for uniformity of this kind. Since the plants are usually placed in a square, 4 by 4 feet, and cultivation is given equally in both directions, it is fair to assume that any infection resulting from this cultivation would also be equal in both directions. Such is not the case, however; the lines of infection are clearly along the rows as they were planted out. A test has often been made of this point by determining from the arrangement of the diseased plants in which direction planting took place, and then having the owner verify the determination. Such determinations have never failed to be correct.

Since in the two fields in question this consecutive arrangement of the diseased plants was very strongly evident, the writer is convinced that the wholesale infection of the plants in the seed bed has been responsible for the excessive amount of disease noted. Loss in this way is obviously preventible by renewing the earth of the bed each year, or at least changing it as soon as mosaic appears in plants taken from it. Several men who have practised this method report that the disease can be quickly got under control in this way.

If the disease in these two fields can be considered preventible by the clean seed bed, then the remaining fields in the table can be taken to represent the general amount of disease arising from various other causes. On this basis the percentage of diseased plants in the remaining twenty-four fields falls at once to 0·28 per cent, or about 1 plant in 400. It is probable that considerable yearly variation will occur, but the figures in the above table may fairly be taken to represent the prevalence of mosaic in the Niagara peninsula for this season (1915).

Throughout the course of the above survey, records were kept of the nature of the soil, the source of the plants, and of the crop which preceded the present planting of tomatoes. On tabulation, these records proved to be so variable that they throw no light on the part played by any of the three factors mentioned, in the origin, yearly recurrence and spread of the disease.

Do mosaic plants yield as heavily as healthy ones? All the evidence seems to indicate that on the whole they do not. When the plant is attacked late in the season the difference in the crop is not readily seen, and may in many cases be small; but the fact that badly attacked fields show unmistakeably a marked lessening in crop would suggest that the same feature is likely to obtain in less pronounced cases, though the diminution may not be apparent to ordinary observation. Since the diseased plants are scattered through the field and the picking is done indiscriminately, it is doubtful if any diminution in the crop not greater than 10 per cent would be discernible under ordinary field conditions. In many of the badly diseased fields seen here the lessening of the crop was quite obvious, and in two or three of these the owners estimated their losses to be one-third to one-half the crop.

Actual evidence on this point has been supplied through the kindness of Mr. F. M. Clement, Director of the Vineland Experiment Station. who undertook to ascertain the weight of the crop from a certain number of diseased plants, and of that from the same number of healthy plants, all from the same field. The results are very striking, for while in the field in question one might after careful observation conclude that there was some small difference in the yield from the healthy and

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mosaic plants, yet this difference would appear so small that it would be estimated at far below the figures which were obtained by actually counting and weighing the fruit. The table below is from Mr. Clement's records:—

Variety.	No. of plants.	Fruits from			
		Healthy plants		Mosaic plants	
		No.	Weight.	No.	Weight.
Danish Export	49	6,659	681	4,740	479¼
Ponderosa	4	219	59	120	50½
Chalk's Early Jewel	6	257	79½	216	69
Totals	59	7,135	819½	5,076	599

Increase in healthy over mosaic plants in number of fruits .... 36·8%
" " " weight of fruits .... 40·5%

In addition to the field observations already recorded, another experiment on this disease was begun. It has often occurred to the writer, in the course of making notes on this affection, that some light might be thrown on the general question of mosaic diseases by growing a diseased plant for a number of generations vegetatively, i.e., by cuttings. These could be grown in as many different soils, and under as many diverse conditions as might be found necessary, and there is a possibility of obtaining valuable additions to our knowledge by a close study of the behaviour of these succeeding generations.

Of all the plants known to the writer to be affected by mosaic troubles, the tomato is perhaps the one which will grow most easily from cuttings, and for this reason it was selected for a preliminary study of this phase of the question.

A tomato plant will grow very well for a long time in a box or a deep flat, and if, after growing towards the light for several days, its position is reversed, it will then grow towards the light again and the stems will form a bow. This bow may then be covered with earth in an adjoining flat, and roots will start out from the underground part of the stem. If the soil in the parent flat is kept somewhat drier than that in the second flat, it will help to induce root formation. It is also advisable to cut partly through the stem between the two flats, or better still, to girdle it, for then the accumulation of food material in the distal part of the stem is a strong stimulation to root production. When the new cutting is well started the connecting stem is totally severed, and the fresh plant thus obtained will grow almost as well as one raised from seed.

Owing to very inadequate greenhouse arrangements, the series that was started in this way did not grow as quickly as desirable, but six generations were secured which lasted for a period of over two years. With greenhouse facilities adapted to this work, there is no doubt that the same number of generations could be produced in about half the time. The plants used were grown in the window of the laboratory, and though they throve in the summer months when heat and light were adequate, it was with the greatest difficulty that they could be kept alive during the dark winter days.

In this preliminary attempt, no variations in the soil were tried out, although the new plants were always started in fresh earth. The original plant was grown from seed and when about a foot high was inoculated with the sap of a mosaic plant from a commercial greenhouse. As growth proceeded it developed very marked mosaic symptoms.

Although the six generations arising from this plant all showed signs of the disease, none of them was so badly affected as the parent plant, and in some cases,

especially among the last of the generations, the presence of the disease could be determined with difficulty. So slight was the evidence in these plants that, had they been met with in the field, they would have been passed over as healthy plants. Still the disease was never entirely absent, and even the diminution noted may have been partly due to unfavourable weather conditions.

While the results so far obtained have presented no new or important features, it is hoped that the extended work now to be undertaken will yield something of value to the subject.

V. REPORT FROM THE FIELD LABORATORY OF PLANT PATHOLOGY, CHARLOTTETOWN, P.E.I.

Paul A. Murphy, B.A., A.R.C.Sc.I., *Assistant in Charge.*

On the inception of the work in this province on July 5, 1915, the season was well advanced and little opportunity was left for conducting experimental work. There was, besides, urgent necessity for the assistant in charge to look around and familiarize himself with the country and the problems which it presented. Every opportunity was taken of attending farmers' picnics and other gatherings and of addressing those present and discussing plant diseases with them. During the first week two meetings were addressed, and thereafter a point was made of being present at all the picnics of farmers which were held on the Experimental Station grounds. A great deal of valuable information was gained in this way and the officer in charge was enabled to decide along what lines experimental work could most profitably be done. Before the end of July it had become clear that the outstanding problems presented were misses in the potato crop, the Late Blight and Rot of potatoes, Club Root of turnips, and the smuts of the grain crops. Although for some of these the season was becoming late, it was decided to begin experiments at once in the hope of being able to obtain results. The experiments are detailed below, in so far as results have been obtained, in the order in which they were begun.

Spraying potatoes with Bordeaux mixture.—A full account of these experiments is given under the section "Plant Pathology," chapter "Potato Spraying B."

Other experimental activity.—An extensive series of co-operative experiments has been planned, and in part begun, to throw light on the question of soil treatment for Club Root of turnips and cabbages (*Plasmodiophora Brassicæ*) on Prince Edward Island. The problem is a difficult one on account of the absence of limestone or other calcareous material, with the exception of a shell deposit known as "mussel mud", and the impracticability of importing lime on account of high freight rates. The absence of drainage, with the consequent production of sour land, is also an aggravating cause which it is hoped the drainage scheme at present being promoted by the Department of Agriculture for the province will, in time, remedy. The experiment is being carried out at five centres on the island and has two questions to answer, namely, "How much lime is needed to control the disease economically?" and, "Will mussel mud take the place of lime?"

More recently, a further series has been planned for the Province of Nova Scotia with the same object in view but using lime and ground limestone instead of mussel mud. It is hoped to be able to give the results in the next annual report.

Several experiments were begun last season on various potato diseases, notably Black Leg (*Bacillus solanisaprus*), to determine the question of possible soil infection and to test the action of various disinfectants on the sets; Powdery Scab, to study the so-called tuber rot and the life-history; and also Leaf Roll, Rhizoctonia, Mosaic, and Curly Dwarf. A study of the length of time the Club Root organism will persist in the soil in the absence of cruciferous plants has been begun also. Of these it is not

necessary to say more at the present than to state that the results will appear in due time.

Scheme for the improvement of the Garnet Chile "seed" potato industry in Nova Scotia.—The author had an opportunity of gaining a preliminary acquaintance with an important potato industry which has been carried on in Nova Scotia for a considerable time when he was instructed to accompany the Director of Agriculture for Bermuda, Mr. E. J. Wortley, through the districts in which Garnet Chile potatoes are grown for the Bermuda trade, in September, 1915. The object of the visit of Mr. Wortley was to carry out the inspection required by the recent order of the Government of Bermuda which requires that no Garnet Chile potatoes be imported into that country unless the crop had been examined during the previous growing season and found satisfactory. A complete tour of all the districts where these potatoes are grown was made and the author visited and inspected almost every individual field. As a result of the examination by the Bermudian authorities, the stock on more than thirty farms was deemed unfit for use as "seed," and leave to import it was refused.

There is no doubt that, from the point of view of the Bermuda planter, the importance of good "seed" is very great. It is a fact of which the writer has since had ocular evidence in the Bermudas that a plant produced from weak "seed" frequently produces tubers, the combined weight of which is less than that of the set from which it sprang. It is also beyond question that good Nova Scotia stock gives a good crop in Bermuda and that fair Nova Scotia stock gives a poor return in the more southern climate. This is the invariable rule. The writer has over and over again traced "seed" from different farms in Canada to various plantations in Bermuda, and has found that if it was a good productive strain here it will give good results in Bermuda, whereas if it were only fair or weak in Canada it will, when planted in Bermuda, give either a very poor crop or else no return whatever. The permanency of the characters of high and low yield are, in this particular case, established beyond question. When one bears this in mind and remembers that every barrel of poor stock imported into the colony entails a loss of from $12 to $24 to the planter who buys it, one is not surprised at the determination of the Government of Bermuda that only the best Canadian "seed" stock be imported and that the poor be rejected.

At this stage the officer in charge of the Field Station for Plant Pathology received instruction from the Dominion Botanist to endeavour to discover the cause of the running-out or degeneracy of the strain, to eliminate the poor stock and grade up the best as much as possible. In the absence of such a course there was serious danger of the trade being lost. When the matter was first brought to the writer's attention, in September, 1915, there was little time available before the close of the season for effecting any improvements. The foliage was dead and the opportunity had therefore passed to rogue the fields and free them from diseased plants. It is possible, however, with a little practice, to pick out the highest-yielding hills from the character of the stalks, it being presumed that by doing so one would get rid of any plants with a tendency towards being run-out and also of all serious hereditary diseases, or at least of such as are carried in the tuber and materially decrease the yield. Three meetings were immediately held which were attended by the principal growers and this course was urged upon them. Two inspectors, one being placed at the writer's disposal by the Department of Agriculture of Nova Scotia, were instructed to direct and help in the selection those farmers who took it up. The movement met with striking success, somewhat more than 60 per cent of the growers in the principal districts going into their fields and hand-selecting a portion of their seed for the following season.

The growers showed such an interest in the movement that a number of "seed potato centres" were organized. The largest, which has headquarters at Clifton, N.S., and which goes by the name of "the Clifton Garnet Chile seed potato centre," has a membership roll of twenty-eight and an estimated output of about 10,000 bushels.

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The president of the centre is Mr. E. A. Logan, and the secretary, Mr. H. H. McNutt, both of Lower Truro, N.S. The second centre, which has for president and secretary, respectively, Mr. David Sutton and Mr. J. T. Healey, was organized at Church Street, N.S., has a membership of eleven and an estimated output of more than 6,000 bushels. It is named the "Cornwallis Garnet Chile seed potato centre". The third, the "Centreville Garnet Chile seed potato centre," has an output of about 2,000 bushels and a membership of seven. The president is Mr. J. A. McDonald and the secretary, Mr. W. P. Wheaton. Sixty-eight per cent of the growers in the areas mentioned have joined a centre, and as they are, for the most part, the largest producers, the percentage of the total output of potatoes which they will raise will be much in excess of that figure.

Little has been said about the scientific aspect of the causes underlying the degeneracy or running-out of our Garnet Chile potatoes when grown in Bermuda, a condition which is also seen to a less extent in Canada. The pressing need of the practical side of the problem for solution has been in part responsible for this. The writer has, however, been paying considerable attention to it since last September and he is carrying out experiments which will, it is hoped, throw some light on the matter. During the visit to Bermuda already referred to, an amount of experience and experimental material was acquired which will prove invaluable. Co-operative experiments with the Director of Agriculture of Bermuda, the Superintendent of the Experimental Stations at Kentville and Charlottetown, and various growers, are planned, the results of which will be reported in due time.

Correspondence and advisory work.—During the course of the year the officer in charge of the Field Station answered a number of requests for information on various plant diseases, and it is pleasing to note that his services are being more and more made use of. A considerable number of farms were visited, some at the request of the owners, and every possible advice and assistance was given. These visits were principally in relation to Club Root of turnips and misses in potatoes, the latter due principally to Black Leg, aggravated by an unusually wet spring and early summer. In such cases it was possible to give information, which, if followed, would largely abate or prevent the recurrence of the evil. The writer, both personally and through inspectors, spent a considerable amount of time visiting farms to advocate the use of Bordeaux mixture on potatoes, spraying not having come into general use yet on Prince Edward Island. During part of the winter months the services of the writer were placed at the disposal of the provincial Department of Agriculture for the purpose of teaching plant pathology at the Short Courses in agriculture, which were held in various parts of the Island. Six courses were attended, namely, at O'Leary, Mount Carmel, Egmont Bay, Murray River, Mount Herbert, and Tracadie. The attendance was remarkably good, amounting in several cases to more than one hundred at each of the thirteen two-hour sessions. From the interest shown in the lectures, which were given on the commonest plant diseases, the author expects good results in the putting into practice of potato spraying, seed treatment for grain and potatoes, precautionary measures for the avoidance of Club Root, and the various other courses advocated. In no other way can one get into close touch with so many farmers and discuss their local problems to better advantage than by the holding of local Short Courses in agriculture.

A commodious Field Station (Plate LXII), in which to carry on the work of the Division, has been erected under the direct supervision of the officer in charge for the province during the past season. It is conveniently situated on the Experimental Station grounds at Charlottetown, and contains a laboratory measuring 17 feet by 15 feet, with three northern lights, an office 13 feet by 9 feet, besides a photographic room, lavatory and hall, and a very large basement for the storage of coal, roots and potatoes. The building is a one-storey bungalow of frame construction and presents a good appearance. It was erected according to the plans and specifications of the officer in charge.

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During the course of the building operations, as in many other ways, the writer has had the benefit of the experience of Mr. J. A. Clark, the Superintendent of the Experimental Station at Charlottetown, to whom he wishes to express his indebtedness. The writer is also indebted for cordial co-operation to the inspectors now or formerly under his charge: Mr. Rolf Holmden, now in the 5th Royal Highlanders; Mr. W. O. Johnston, Mr. M. H. Jenkins, and Mr. S. G. Peppin.

VI. REPORT FROM THE FIELD LABORATORY OF PLANT PATHOLOGY, FREDERICTON, N.B.

(G. C. CUNNINGHAM, B.S.A., *Assistant in Charge.*)

The laboratory was established July 1, 1915, for the purpose of conducting the work of the Botanical Division, in the province, in conjunction with the Dominion Experimental Station at Fredericton, N.B. The work to be undertaken naturally falls under two headings, research and educational extension. The officers will spend much of their time assisting the farmers in controlling and eliminating plant diseases, which are seriously injuring their crops. This will be accomplished by conducting illustration experiments and demonstrations in various sections of the province, and by giving addresses on plant diseases before the various agricultural conventions and conferences, which are frequently held. The main object of the laboratory will be to conduct research on diseases of agricultural crops and other botanical problems pertinent to the advancement of agricultural science in the province of New Brunswick.

The need for this laboratory is apparent when we consider the great losses which are caused annually by plant diseases. Approximately 50 per cent of the possible potato crop was destroyed by disease during the past season. A field survey conducted last summer on 100 farms in the larger potato-growing areas showed that the average loss caused by four common diseases amounted to 47 per cent of the total possible crop, or about 5,640,000 bushels. These diseases and the ensuing losses were: Blackleg, 7 per cent (840,000 bushels); Rhizoctonia (Little Potato Disease), 5 per cent (600,000 bushels); Mosaic, 10 per cent (1,200,000 bushels), and Late Blight (Rust), 25 per cent (3,000,000 bushels).

Some other diseases are equally injurious. Club-root of turnips and cabbage has become so serious in the Maritime Provinces that many farmers have abandoned turnip growing, because of its ravages. The apple scab and other diseases of fruit trees cause considerable damage and are in urgent need of investigation. These and many other problems will be studied as opportunity presents itself.

The department was especially fortunate in securing the second floor of the old post office, lately occupied by the Customs and Immigration officers, on the corner of Queen and Carleton streets, for this laboratory. The work of fitting up these rooms is now under way, but has been delayed somewhat until the previous occupants could have their new quarters equipped. The space thus supplied will prove ample and in every way suitable for the work, as well as being convenient for the general public. It is proposed to leave the description of this laboratory for a future report, and until the building is properly fitted up.

In spite of the fact that the laboratory was not established until late in the season, considerable preliminary work has been accomplished which will serve as a basis for future investigations. During the summer material and information was collected for work on the Mosaic and Rhizoctonia diseases of the potato and on Club-root of turnips. A few results obtained on potato spraying have been reported in another section. Observations on the resistance of plants to disease are interesting and will be recorded here. Experiments were conducted to determine the influence of different fertilizers on the following potato diseases: Common Scab, Rhizoctonia, Late Blight Rot and Silver Scurf. Another series of studies was conducted on the resistance of different varieties of potatoes to disease; these results will be withheld

until further information has been obtained. The following report partially covers the work of the past year:—

Acknowledgments.—I desire to acknowledge the valuable assistance of the Dominion plant disease inspectors who have been connected with this laboratory, particularly Mr. George Partridge and Mr. J. R. Brownlee, who conducted the spraying on the experimental plots. I am indebted to the Provincial Department of Agriculture for having provided temporary quarters for myself and assistants during the past season and for encouragement and aid in numerous other ways. I further wish to acknowledge the co-operation, advice and assistance of Mr. W. W. Hubbard, Superintendent of the Dominion Experimental Station. He has encouraged the work by supplying land, seed and labour for the experiments and by permitting me to use his experimental plots for plant disease studies.

Correspondence.—During the first five months after the laboratory was established, the correspondence was small, but during the last four months it has been rapidly increasing. In all, 818 official letters and 456 circular letters, in addition to 2,450 posters and programmes, advertising the New Brunswick Potato Growers' Association, have been sent out. The rapid increase in our correspondence is an indication of the interest taken in our work by the general public. This end of the work will undoubtedly continue to increase as the farmers become more acquainted with our work, and as we accumulate information which will be of service to them.

Meetings attended.—Considerable time was devoted to attending and addressing agricultural conferences and conventions. During the winter months the writer delivered twenty-two addresses at various meetings on the following subjects: (1) "Types of Plant Diseases," (2) "Potato Diseases," (3) "Potato Improvement and Seed Selection," (4) "Preparation and Application of Sprays and Disinfectants," (5) "Club-root of Turnips and Allied Plants, and its Control," (6) "Bacteria in Relation to Dairying." The following are among the more important meetings attended and addressed: (1) Farmers' Short Course, at Bathurst, N.B., (2) School Teachers' Course in Agriculture, at Sussex, N.B., (3) Farmers' Short Course, at Truro, N.S., (4) Farmers' Short Course, at Sussex, N.B., (5) Annual Convention of the Nova Scotia Farmers' Association, at Windsor, N.S., (6) Farmers' Short Course, at Yarmouth, N.S., (7) Farmers' Short Course, at Lawrencetown, N.S., (8) Annual Convention of the New Brunswick Farmers' and Dairymen's Association, at Fredericton, N.B., (9) Annual Seed Fairs, at Sussex and Chatham, N.B., (10) The New Brunswick Potato Growers' Convention, at Woodstock, N.B.

New Brunswick Potato Growers' Convention.—Potato growing, which is possibly the greatest agricultural industry in New Brunswick, required considerable attention. As there was no body of interested growers which could be used as a medium for spreading information, or as an organization to work in behalf of potato improvement, steps were taken to form such an association. At a convention of potato growers held at Woodstock on March 22 and 23, this question was brought forward and the convention developed into the permanent organization of the New Brunswick Potato Growers' Association.

The association has been organized to promote the interests of the potato industry in the province of New Brunswick, by disseminating information on methods of cultivation, suitable varieties, seed improvement, grading, standardizing, marketing, and eradicating and controlling fungus and insect diseases, and allied subjects. It has adopted a wide and efficient policy for carrying into effect the work on potato improvement and it already promises to be an important factor in the development of the industry.

During the coming season, special attention will be given to the improvement of potatoes for seed and table purposes, through seed selection and the control of potato

diseases. The association hopes to accomplish this task by having its members conduct co-operative experiments along several lines. These will be planned and supervised by the staff of this laboratory and the results recorded in our annual report. Such experiments, if properly conducted, will be productive of valuable information to us and will also serve as much-needed illustrations of what can be accomplished on the ordinary farm.

Variety Resistance of Potatoes to Disease.—Eighty-one different varieties of potatoes were studied during the season to determine their comparative resistance to some of the more common diseases. During the growing season the tops were examined twice and the occurrence of the following diseases noted: Late Blight, Early Blight, Tip Burn, Mosaic, and Rhizoctonia. Owing to the voluminous nature of these records, and also because the seed stock was not necessarily free from disease, which is a very important requirement in such studies, it does not seem advisable to report on them in detail until more information has been obtained. However, it seems well to call attention to the fact that the results obtained this year are sufficiently promising to warrant the work being continued more extensively next season. This was particularly noticeable in connection with Late Blight and Mosaic resistance. The following varieties showed considerable resistance to Late Blight: Brydon's Beauty, Brydon, Fannie Dean, Monarch, New Chieftain, New Scotch Rose, Pierremont Seedling, Provost, Superlative, Scottish Triumph, Table Talk, Up-to-Date, Vicks' Extra Early, and White City. The following varieties appear to be among the most susceptible: Acquisition, Burbanks' Seedling, Carman No. 3, Clyde, Dreers' Standard, Early Nebraska, Early Ohio, Early May, Early Six Weeks, Early Triumph, Everett, Queen of the Hebron, Rawlings' Kidney, and Wee McGregor. There was also considerable variation in respect to the Mosaic disease; some varieties were completely free, while others were badly infected.

During the winter months, one bushel of tubers of each variety was carefully examined for the occurrence of Common Scab, Rhizoctonia, Silver Scurf, and Late Blight Rot. This work was not so promising, but will also be continued during the coming season.

VII. GENERAL.

Changes in Staff.—New Field Laboratories.—Two new field laboratories of plant pathology were established during the year. One was erected in form of a small suitable building in the grounds of the Experimental Station at Charlottetown, and covers for the present time the requirements of the provinces, Prince Edward Island and Nova Scotia. The Hon. Martin Burrell, Minister of Agriculture, authorized the appointment, as officer in charge, of Mr. Paul A. Murphy, B.A., A.R.C.Sc. I.

Mr. Murphy has had an exceptionally useful training in botany and plant pathology. He received his preliminary education at the Royal College of Science, Dublin, and later held a position as assistant under the Irish Department of Agriculture. He was then fortunate in receiving a travelling scholarship, and spent one year at the most important plant pathological centre of Germany. One year of study was spent at the Imperial College of Science, Kensington, England, and one year at the department of Plant Pathology of Cornell University. The experiences of an officer of Mr. Murphy's training will be most valuable to the Canadian farmer.

The field laboratory at Fredericton, which occupies very satisfactory quarters in the old post office building, is in charge of Mr. G. C. Cunningham, B.S.A. Mr. Cunningham graduated from the Agricultural College at Guelph. He then occupied several positions in the United States and finally was appointed Associate Plant Pathologist of the Experiment Station, Burlington, Vermont. He was offered a position under this Government some few years ago, but the station authorities induced him to remain

there. The work which Mr. Cunningham has done, especially in connection with the study and control of Club Root and Potato Scab, has shown him to possess valuable gifts of observation and powers of research which are most acceptable.

Both officers commenced their work in July, 1915.

Mr. F. Lisle Drayton, B.S.A., Assistant Plant Pathologist, was granted leave of absence from September to join the military forces. Miss Faith Fyles, B.A., Assistant Botanist, was absent on sick leave from December to the end of the fiscal year.

Although the absence of these two officers was considerably felt, every effort was made by the remaining staff to take charge of the work that otherwise fell to their absent colleagues.

Library, Records and Scientific Collections.—Apart from the routine clerical work and special experimental and investigation work, there have been in the past and are now accumulating various details involving often a technical knowledge of wide scope. Among such work were the arranging, numbering and indexing of the Divisional library, with the almost daily recording of numerous pamphlets and periodicals received. The desire is to obtain a comprehensive and well-arranged technical library so that the same may be available to every consultant.

Some 268 specimens of local flora have been added to the herbarium. The mycological collections have also been arranged for consultation, similarly to the flowering plants herbarium. The keeping of records of the work done by the Division is also occupying considerable time; this includes the keeping of photographic records of individual diseases, or experimental observations.

Nitro-Culture Work.—(Plate LXIII).—Last year a start was made by supplying the various Experimental Farms with cultures, prepared in the Ottawa Laboratory, of leguminous root-nodule bacteria. Some seventy-five cultures were sent out last year. When we state that the increase to date has been over ten-fold and the work is still only in its first stages, it will be easily understood that, with the reduced staff, the energy of those remaining was very highly taxed. Acknowledgements in attending to this work are due to Mr. P. R. Cowan, B.S.A., who, in his spare moments, when not attending to his duties as plant disease inspector, brought much interest and appreciative skill to bear.

In view of the fact that it has been established that plant diseases such as Club Root, Potato Rosette and Powdery Scab and others may be conveyed by the use of infected soil, it is considered advisable to replace inoculation with soil, as much as possible, by seed inoculation with pure culture when there exists no such danger, and when, no doubt, considerably more active bacteria are introduced.

Experience would also indicate that use of cultures should preferably be restricted to alfalfa. For many years before one ever thought of bacteria in relation to the growth of legumes, red clover, white clover, and alsike have been grown in Canada and without cultures became excellently established. The same applies in a large measure to ordinary beans and peas. Alfalfa, no doubt, is benefited by inoculating organisms, and cultures will be at the disposal of any farmer free of charge.

Publications.—In conclusion, the following list of publications may be mentioned:—

John Adams, M.A., Bulletin Second Series No. 28, "The Cultivation and Handling of Flax for Fibre." Also Exhibition Circular No. 77, "The Cultivation of Flax for Fibre."

P. A. Murphy, B.A., A.R.C.Sc.I., Circulars No. 10, "Late Blight and Rot of Potatoes;" No. 11, "The Black Leg Disease of Potatoes." Exhibition Circulars No. 81, "Potato Spraying for Late Blight and Rot;" No. 82, "Black Leg Disease of Potatoes."

OTTAWA.

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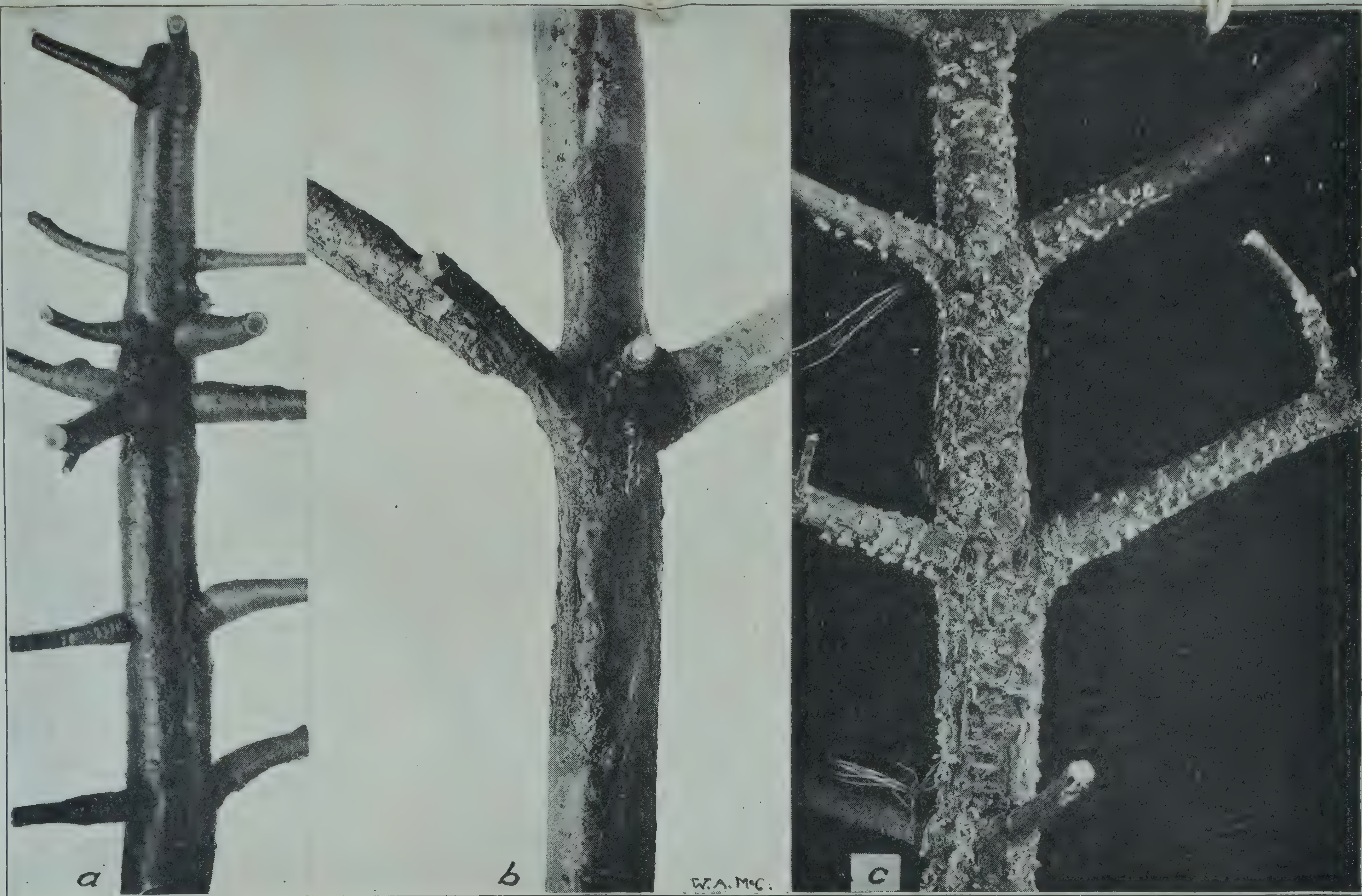


White Pine Blister Rust.

(a) Early stage of the disease on a pine seedling. (b) Later stage on a young pine showing complete girdling of the stem. (c) An affected pine limb in spring, covered with the rust blisters. Above this rusted section the limb is dead.

Plate LIV.

White Pine Blister Rust; the stage on black currant leaves.

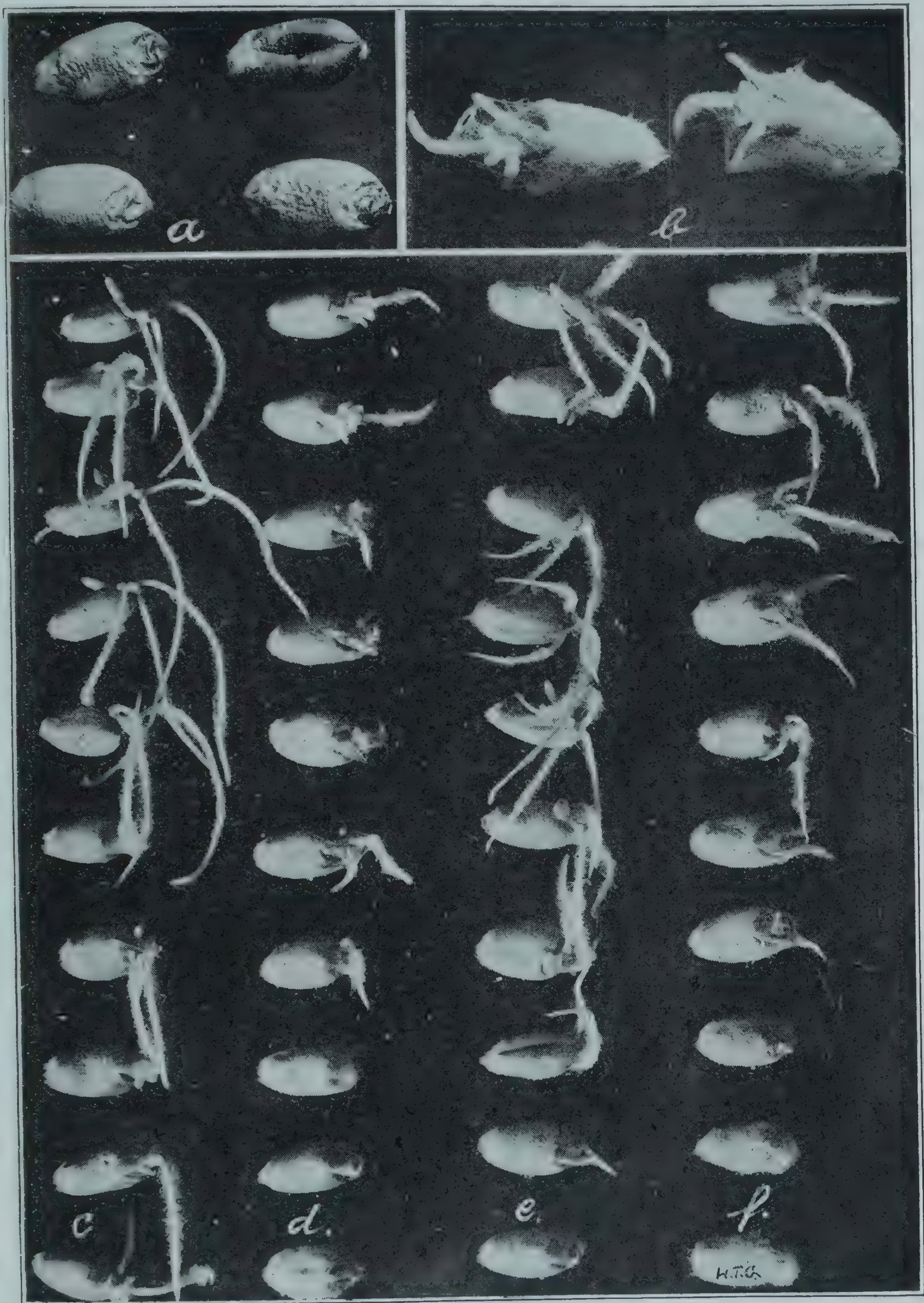
White Pine Blister Rust.

(a) Normal condition of healthy black currant shoots on October 3.
(b) Rusted shoots taken on the same day. They have been long defoliated by the rust and a new set of leaves has been formed by premature development of the winter buds. As all these secondary leaves will die in winter, the effect on the plant is very harmful.
(c) Spraying for currant rust. The two rows on the left were unsprayed, and were defoliated early. The two on the right were sprayed eight times with Bordeaux mixture. While not entirely rust free, they kept their leaves till the normal time of leaf-fall.

PLATE LVI.

Effect of wet season on badly drained field of potatoes.
In this case the potato crop is a failure. The water standing between the rows should have been carried off by shallow surface trenches, then the crop might have been saved.

PLATE LVII.

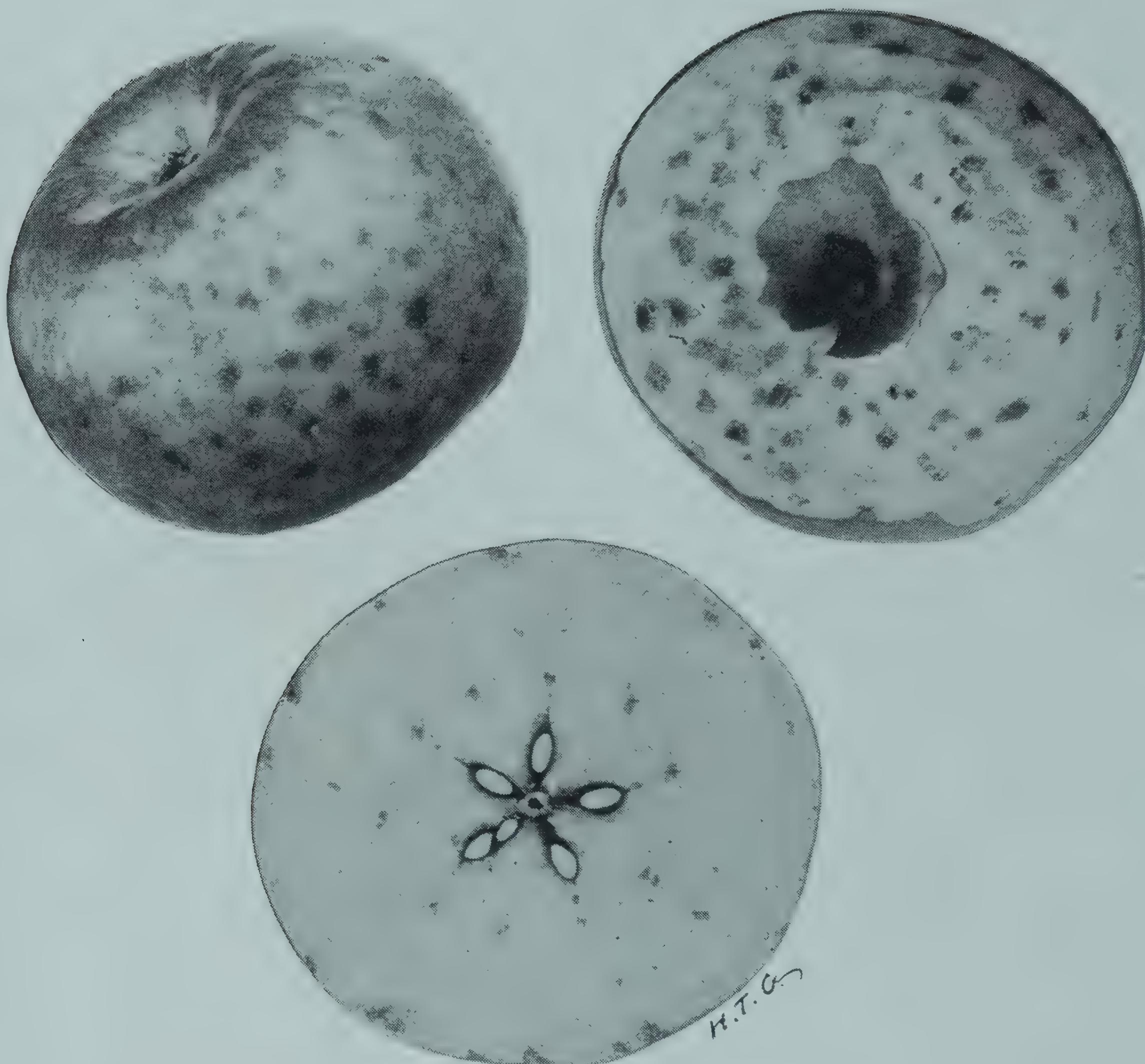


Effect of wet weather on Wheat grains.

(a) Four wheat grains showing blackish colour.
(b) Same grains on germination become covered with mould. Under field conditions a large percentage will not produce plants.
(c) 10 seeds soaked for 6 hours in water then treated for $2\frac{1}{2}$ min. in sulphate of copper sol. 1·100. Mould entirely disappeared, germination good.
(d) 10 seeds soaked for 6 hours in water then treated for $4\frac{1}{2}$ min. in formalin sol. 1·400. Mould not quite controlled, germination slow.
(e) 10 seeds treated for $2\frac{1}{2}$ min. in copper sulphate sol. 1·100 without previous soaking. Mould not entirely controlled.
(f) 10 seeds treated for $4\frac{1}{2}$ min. in formalin 1·400 without previous soaking. Mould not much checked, germination least good.

Note.—The treatments tried are the same as employed for smut in grain. It will be seen to be of advantage when practising treatment described under "c".

PLATE LVIII.



Bitter Pit of Apples. — An apple showing bitter pit markings externally ; one showing this very undesirable spotting after peeling the apple, and also section of same apple showing internal spotting.

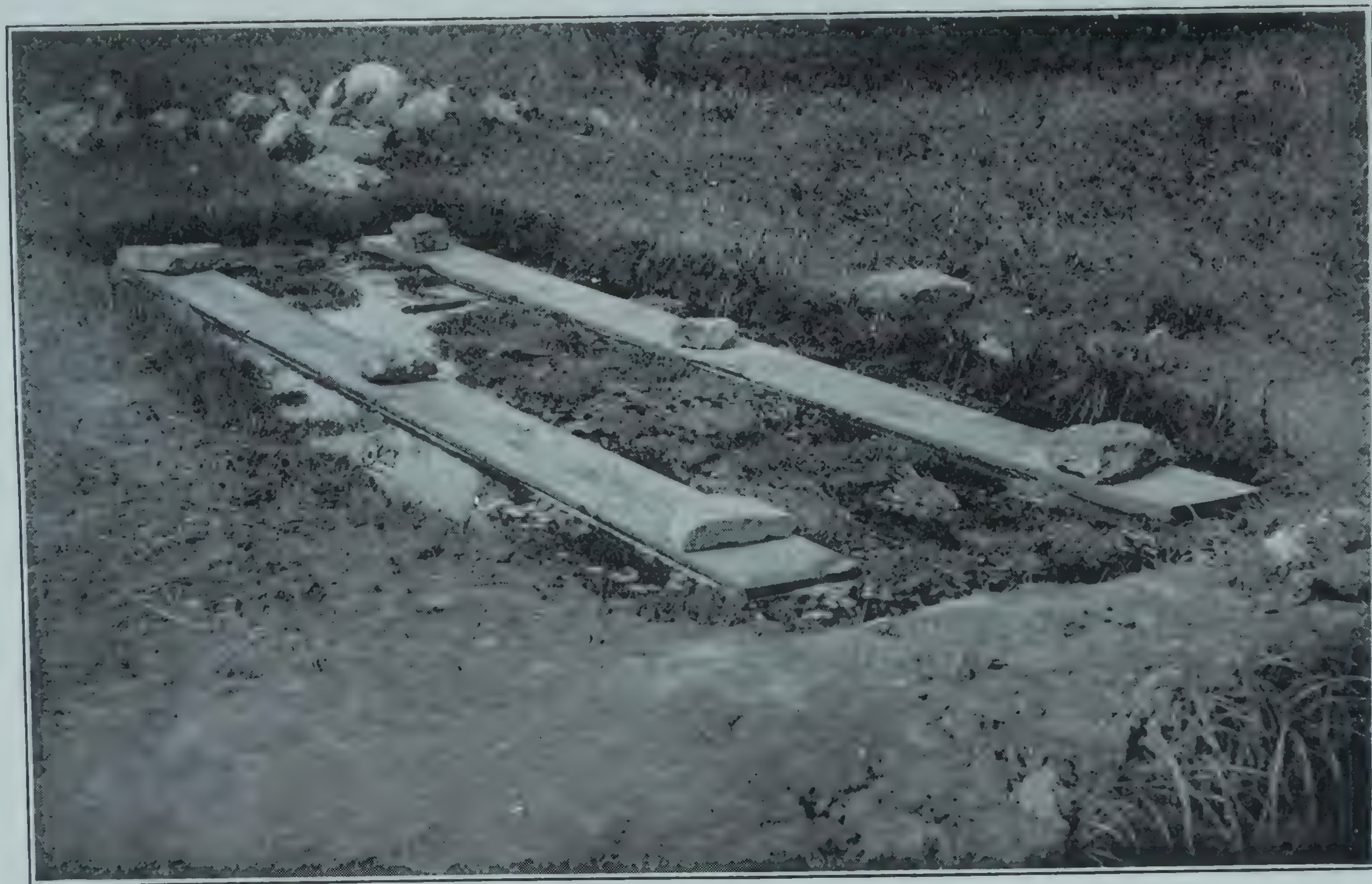


Photo by F. L. Drayton.

Experiments with Flax.—Retting tank dug in ground. Flax bundles are submerged in water being placed into these and allowed to remain until completely retted.

Photo by F. L. Drayton.

Germination of Wild Rice. — Seed of wild rice collected in fall should be buried in soil over winter and when tested in spring it will germinate as shown above.

PLATE LXII.

The Dominion Field Laboratory of [illegible] of the Division of Botany, at Charlottetown, P. E. I.

Root Nodules of Clover. — This clover shows numerous root nodules produced by the nitrogen fixing bacteria supplied in the so-called "nitro culture" supplied by this Division.